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PROCEEDINGS OF THE EIGHTEENTH COTTONSEED PROCESSING CLINIC

Held at New Orleans, Louisiana

February 3 and 4, 1969

Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

PREFACE

The Cottonseed Processing Clinic is an annual event sponsored jointly by the Southern Utilization Research and Development Division and the Mississippi Valley Oilseed Processors Association. Its purpose is to acquaint representatives of the cottonseed industry with current developments in utilization research and to provide for an exchange of information that will benefit industry and future research. Included for discussion in this year's program is a series of panel topics pertaining to the potential of producing and processing of sunflower seed.

These proceedings report the statements presented by the various speakers during the 1969 Clinic and give an account of the discussions during the three sessions.

C. H. FISHER, Director
Southern Utilization Research
and Development Division

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PROCEEDINGS OF THE EIGHTEENTH COTTONSEED PROCESSING CLINIC HELD AT NEW ORLEANS, LA., FEBRUARY 3 AND 4, 1969

WELCOME

by

C. H. Fisher, Director
Southern Utilization Research and Development Division
New Orleans, La.

I am happy to again represent the Southern Utilization Research and Development Division in welcoming all of you to this Cottonseed Processing Clinic, the 18th in this series of meetings. A great deal has happened and much time has elapsed since these conferences were started. We in the Division look forward with keen anticipation to these Clinics, which, as you know, are sponsored jointly by the Mississippi Valley Oilseed Processors Association and USDA's Southern Utilization Research and Development Division. We appreciate very much the privilege of working with the Association and with leaders in the oilseed industry. This cooperative effort has been and is very helpful to us in achieving our mission of aiding – through research – the farmer, the processor, and the consumer.

As already stated by Chairman Woodruff, we have an excellent program for our Clinic. For this we are grateful to our Program Committee, whose members are listed in the program. This Committee is chaired by Tom Allen and co-chaired by Bruno Wojcik and Laurence Mazzeno, Jr. While expressing appreciation, I would like also to thank General Chairman Ralph Woodruff, Tom Allen, President George Wildrick, and other officers of the Association for their valuable help in planning and arranging this Conference.

At these Clinics I usually report highlights of the year in our Division. We are now in our new building, which houses two pilot plants: one for the mechanical processing of cotton and the other for the chemical processing of cotton. Our new laboratories, located in the old building, are completed and ready for use. We are grateful, of course, for the new and useful facilities, which will make it easier for us to do research.

Our scientists and engineers continue to be highly productive. Our research progress last year is described in some 40 patents and almost 300 publications. I wish to thank the members of our staff for their productivity and dedication to our mission.

Industry continues to adopt and use our research. There are a number of such instances for the past year. We are grateful for the interest in our work and cooperation that resulted in the commercial use of some of our research.

It is clear that a great deal of planning and hard work are required to arrange these Clinics. I wish to thank everybody contributing to the success of this Clinic. Particularly, I would like to thank the officers of the Association, our General Chairman, the Session Chairmen, speakers, our visitors, and the staff of our Division.

I think that Dr. Wojcik and his staff deserve special mention and special thanks for skill and hard work in arranging this and other successful conferences.

I hope all of you will enjoy the Clinic and your stay in New Orleans. Please visit our laboratory and talk with our scientists and engineers if you have an opportunity. We cordially invite you on any occasion during the year to visit us individually or as groups.

OPENING REMARKS

by

G. Wildrick
Lake County Oil Mill
Tiptonville, Tenn.

Tom Allen called me one day and asked if I would make a few opening remarks at this Clinic. "Tom," I said, "that is a broad topic – opening remarks. What suggestions do you have?" He said, "Keep it brief and keep it light."

Sometimes those of us in the Cottonseed Processing business get in a rut, and sometimes we need to get out of that rut. I can suggest one way that you can get out of the rut. If your thinking is getting a little stale and you are sitting around feeling sorry for yourself; you haven't made any money in the last 2 or 3 years; you haven't enough cottonseed; you haven't had enough spread in them; you haven't sold your products high enough; and you haven't bought your seed cheap enough; then you may be in a rut in your thinking.

I found myself in a pretty bad rut some 6 or 8 months ago. As I say, I can suggest one way that you can get out of that rut. It has to do with health. Lots of time when we feel better we think better. If we are full of pep and full of energy it shows in our thinking. So, for your consideration, I offer two words of advice. One of them is to quit smoking. It will make you feel better. After you get over the physical desire it will make you feel better. Of course, you will gain some weight. You will pick up 10, 15, 20, 25, 30, 35 pounds and that has to do with my second bit of advice to you.

The second bit of advice is to drop some weight, get lean, get skinny. You will find yourself with a tremendous amount of energy. You will find yourself with the amount of energy you had some 10 or 15 years ago. However, in looking around, I see that this advice cannot apply to everyone because I see some very lean people here. I see some people here that I know do not smoke any more. But this will help – it helped me and I am no doctor, but I think it will help you. I think it will help anyone who will do it. It is a hard job. They are both hard jobs, but there is a certain feeling of delight when you have conquered both, when you can control yourself as far as your smoking is concerned and as far as your intake of fattening foods is concerned.

SOUTHEASTERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION'S PROGRAM ON OILSEEDS

by

F. R. Senti, Deputy Administrator
Nutrition, Consumer and Industrial Use Research
Agricultural Research Service, USDA
Washington, D. C.

Most of you are familiar with the U. S. Department of Agriculture's program of utilization research, through which our scientists strive to find new uses for agricultural products. The facilities here in New Orleans are part of the program, as are the regional laboratories in California, Illinois, and Pennsylvania. A fifth regional laboratory is nearing completion in Athens, Ga., and it is this most recent addition to our utilization research program that I would like to tell you about today.

First, a word about how the new laboratory came into being.

During the past few decades, agriculture in the South has been undergoing drastic change. As this group is well aware, many factors have influenced farmers to reduce cotton acreage and to introduce a more diversified agriculture. Meat and poultry production has been on the increase, and demand for feedstuffs has risen accordingly. There are fewer laborers and more machines. These and other factors all suggested that expanded research efforts were necessary to solve the new farm problems that have arisen as a result of these changes.

Plans began to take shape in 1962, when Senate hearings began on the need for research to find new and expanded uses for agricultural crops of the Southeast.

In 1963, Senator Richard Russell officially proposed to the Senate that a new laboratory be built in Athens. Funds for the laboratory were included in the 1964 Agricultural Appropriations Bill. Architectural plans were developed and construction was begun in 1966. In 1968 the Congress appropriated the last of the money that was needed to meet the original plans. We expect completion of the facility sometime this spring.

Officially, the new plant will be known as the Southeastern Agricultural Research Laboratory. This designation departs from those of the other four regional labs, whose staffs work only in the field of utilization research.

At the Southeastern lab, utilization men will work alongside entomologists and economists, as well as specialists in plant science, animal science, soil science, and marketing.

Such a blend of scientific disciplines will permit us to start with a problem in the field or orchard and follow it through the succeeding steps of harvesting, processing, distribution, and even merchandising.

Southeastern will be the first laboratory in the Agricultural Research Service to feature such a broad range of scientific disciplines.

Before I discuss the oilseed research that we plan to do at Athens, I would like to brief you on some of the other aspects of our program. I am sure your interests encompass the agricultural complex of the South as a whole. We will work, of course, with the crops of importance of the Southeastern States. These include fruits, vegetables, and tree nuts; animal products – with particular emphasis on poultry products and pork; and feeds and forages – particularly the southeastern grasses, such as Coastal Bermudagrass, as well as peanuts and other southeastern oilseeds. We will seek new and more efficient methods of processing and producing these farm commodities. In our processing research, we will give attention to the increasing problems of pollution that are arising in agricultural industry, and will devote considerable effort to processes that minimize waste product formation or which convert wastes into usable products.

Some specific goals for the laboratory include:

Greater degree of mechanization for the vegetable industry of the Southeast and expansion of the

processed vegetable industry.

Better ways to process the region's large and increasing peach crop.

Longer shelf life for highly perishable nuts, particularly pecans.

More uses for poultry meat, particularly in the form of the popular "convenience" foods and solution of problems relating to Salmonella infection.

More mechanization in food processing, to cut down on the possibility of contamination through human handling.

Better methods of dehydrating, ensiling, and encapsuling forage so as to get more food value out of this important southeastern crop.

Each of these commodities – fruits, vegetables, poultry, forage – represents an industry worth many thousands of dollars annually to the Southeast. If research can raise the efficiency of each industry by but a few percentage points apiece, it would mean a substantial boost to the economy of the region.

Now, to the subject of more immediate interest to the members of this group – the oilseed research that we plan to do at the Southeastern lab.

As the program for this meeting suggests, the new oilseed crop of much current interest is sunflowers. The reason for the sudden interest in sunflowers is traceable to the success that the Russians have enjoyed in the sale of sunflower oil. Foreign markets that were once prime customers for U. S. soybean oil are now turning to Russian sunflower oil.

This is somewhat ironic, for the "Rooshian peanut" is really native of American soil. It has been grown for many years in the Red River Valley of the North, primarily for use as birdseed or as a confection. Its possibilities as an oilseed crop have never been fully exploited here, partly because soybeans and other crops seemed so much more attractive as oil sources.

In Russia, however, where the weather in most regions is too harsh to permit soybean production on any scale, the hardy sunflower has been the object of intensive study during the past decades.

The result has been the development of Russian varieties with seeds that contain up to 60 percent oil, as compared to yields of around 25 percent for the varieties produced in this country.

Some exploratory research has been conducted recently by ARS scientists located at the Northern Regional Research Laboratory at Peoria, Ill. The work at Peoria involved the analysis of the composition of sunflower kernels and hulls and assessment of the food value of the product.

One aspect of sunflower oil that our men at Peoria found particularly interesting was its linoleic acid content – about 70 percent. Linoleic acid content, as you know, is related to the value of an oil as a "polyunsaturate," the higher the better. Sunflower oil ranks nearly as high as safflower oil in linoleic content; thus, it will have high polyunsaturates as a plus value for food uses.

NURDD also examined minor constituents of sunflower seed and meal that might affect its utilization. The major phenolic component of the meal is the ubiquitous chlorogenic acid. However, small amounts of several other phenolic compounds are present. These phenolic compounds readily discolor on oxidation or pH change and affect the color of meals and protein prepared from sunflower seeds.

The sugar fraction of sunflower meal has been examined and at least four sugars have been isolated.

Exploratory work suggests that oils from Russian varieties of sunflower are more resistant to autoxidation than those of other accessions examined. The reason for this difference is not apparent.

There is little difference in amino acid composition of meal among seven sunflower varieties analyzed. Analyses indicate that the meal is nutritionally deficient only in lysine for pigs; lysine and isoleucine for humans; and lysine, leucine, and threonine and perhaps isoleucine, glycine, and the sulfur-containing acids for young chicks. Hulls also varied little in composition; lignin, pentosans, and cellulose make up about 75 percent of the total. There is somewhat more lignin and less pentosans and cellulose than in oat huls, wheat straw, bagasse, and corncobs.

Following the completion of the Southeastern Laboratory, all work on sunflowers will be transferred from Peoria and incorporated into an expanded effort at Athens. Indeed our Southeastern Laboratory is initiating research on sunflower by supporting a grant project at Texas A & M.

Sunflower acreage in the North declined last year, but there was a sharp increase in the South. In North Dakota, for example, 52,000 acres were planted to oil-variety sunflowers in 1967, but only

26,000 acres were planted in 1968.

In the South, on the other hand, sunflower acreage went from virtually nothing in 1967 to 45,000 acres in 1968 and is expected to double or even triple this year.

Farmers of the North are limited to but one crop per year, whereas in the South there are possibilities for a least two crops.

Sunflower is especially well-suited for the Cotton Belt. Existing cottonseed mills can crush sunflower seeds; large capital outlays for new milling equipment would not be necessary to accommodate the new crop. Indeed, the mills could be put to use during times when they would otherwise be idle.

Further, sunflowers are a versatile crop and can be grown in rotation with a variety of other crops. In the South, they could very likely be grown in combination with wheat, peanuts, or some other crop on a two-crops-per-year basis.

So you can see why we are looking forward to getting into our new facilities at the Southeastern lab and taking up our investigations of this promising new crop.

There will be a number of problems to tackle. There is need for information on the optimal use of equipment and methods for processing the seed and refining sunflower oil. Information is needed on how best to dehull seeds so that a good quality meal can be obtained for use as animal feed. Data are needed on bleaching, winterizing, hydrogenating, and storing sunflower oil.

Scientists at USDA have been asked for information on what to do with the hulls – they make up 25 percent of the seed's weight – and on possible uses for the sunflower plant itself, which at present is left in the field.

Other problems of sunflower production that have been reported include instability of the seed meats; stability properties of the oil; and the appearance of a "haze" in the refined oil, the result of a microcrystalline wax.

There is a potential problem of removing pesticide residues from sunflowers during processing. Research is needed on methods of processing the meal to obtain high-protein concentrates for food use. Data are needed on the nutrient composition of sunflower seed meal as influenced by processing conditions. These are some of the areas in which research will be conducted.

We plan to develop a pilot plant that will provide data on all aspects of sunflower oil processing. Some of the products that we hope to perfect through our research at Athens are:

High-quality cooking and salad oils for domestic and export markets.

Polyunsaturated oil with bland flavor for use in such foods as emulsion-type margarines, mellorine, and toppings and other specialty products to replace imported coconut and palm oils.

A bland, defatted flour for use in such food products as breakfast cereals, bakery products, protein-type beverages, meat products, and meat analogues.

Low-fiber, high-protein feed meal for use in poultry feed – plus sufficient information on the nutrient content of the meal so that it can be used in computer formulation of feeds.

A ruminant feed made from hull fractions and pods in which at least 80 percent of the carbohydrate is available as food energy.

I am sure that we shall hear more about sunflower production research tomorrow. At this point, it is impossible to say what the future of the sunflower in Southern agriculture will be. It depends on a number of factors, chiefly whether sufficiently high yields can be obtained and whether we can control such insect and disease pests as the head moth and mildew. Efforts to solve these problems already show promise. Through further research, including the programs that are planned for the Southeastern Agricultural Research Laboratory at Athens, I feel confident that we can one day confer on sunflowers the status of a major southern crop.

SESSION I: G. F. Wallace, The Union Oil Mill, Inc., West Monroe, La. Chairman

PROTEINS – PRESENT AND FUTURE TRENDS

by

H. L. Wilcke
Ralston Purina Co.
St. Louis, Mo.

Many conferences have been held, many speeches have been made, and much has been written about the world food supply. There is general agreement in the conclusions of all of these means of communication, that the most serious shortage in our world food supply is protein. There are those who have felt that we in the United States should attempt to supply the necessary high protein products to make up these deficiencies. There is one very serious drawback to this line of approach, and that is where is the money coming from to pay for the products that we might export? There is a real difference between need and effective demand or, in other words, the ability to pay for the food that is needed.

Much thought has been devoted to possible sources of new high protein materials to supplement those we now have. One of the possibilities that has been suggested is the production of protein from the hydrocarbons obtained from petroleum. Either yeast or bacteria may be grown on these compounds when oxygen and nitrogen are supplied. The petroleum companies have spent large sums of money in developing this type of product and at least three of them are proposing to be in production in quantity within the next 2 or 3 years. Initially, the yeast protein from petroleum sources will be produced for animal feed, but the eventual goal of the producers of protein from petroleum is the human market. In the meantime, the yeast protein so produced may very well be a competitor for the oilseed proteins if the product can be produced at a competitive cost.

The production of a fish protein concentrate, or marine protein concentrate, from whole fish has been the subject of much discussion, promotion, and research work. After a very intensive effort by the U. S. Department of Interior, a method has been developed up to a certain point, and the product as produced by this method, which involves extraction of whole fish with isopropanol, has been recognized by the Food and Drug Administration as being suitable for human consumption. However, in spite of several years' work and the expenditure of considerable sums of money, this product is still not on the market except in a very limited way at a very high price.

Algae have been considered as a source of protein. There are certain problems with the consumption of algae by humans and also some problems in removing the moisture from this type of product. Furthermore, leaves have been considered as a source of protein. The consumption of even small quantities of this product results in gastric distrubances, a problem which must be overcome. It is evident that there has been a wide range and rather thorough study of possible sources of protein that may supplement our present supplies.

During the past year our more conventional types of protein have been increased in production. The soybean industry has responded by producing a crop of about a billion and a quarter bushels for the first time in history. There has been a decided increase in cottonseed meal production over the previous year with a total available supply of almost 2 million tons of cottonseed meal. The fisheries industry throughout the world have increased their catch to about 60 million tons, an increase of almost 10 percent.

It is against this background then that we are considering the present status and the future possibilities for cottonseed protein.

The traditional and almost exclusive use of cottonseed meal has been for feeding purposes. Most of this has been used as food for ruminant animals. At one time most of the meal or cake was purchased

direct from the processor by cattlemen, but the trend in the last few years has been toward increased usage by the manufactured feed industry. In table 1 we have presented the total tonnage of manufactured

Table 1. – Manufactured feed statistics[1]

Item	1962-63	1964-65
Total manufactured feeds (est.) tons	41,260,000	43,560,000
Soybean meal, pct. of total	20.8	20.2
Cottonseed meal, pct. of total	2.4	3.5
Soybean meal, tons	8,575,000	8,799,120
Cottonseed meal, tons	990,240	1,524,600

[1]Decossas, K. M., Molaison, L. J., Kleppinger, A. de B., and Laporte, V. L. 1968. Cottonseed oil and meal utilization. Jour. Amer. Oil. Chemists' Soc. 45:83A.

feeds for the 2 years, 1962-63 and 1964-65. It will be noted that there was a decided increase in the use of cottonseed meal in these manufactured feeds during that period. The use in 1964-65 amounted to a million and a half tons, which represents more than 50 percent increase in that 2 year period.

Since the ruminant animals have been the primary consumers of cottonseed meals, the consumption by dairy cattle and by beef cattle and sheep are presented in table 2. In this table, for comparison we have presented the amount of soybean meal used for these same species of animals. It is obvious that

Table 2. – Cottonseed meal and soybean meal consumed in feeds 1959-67[1]

Year	Dairy cattle		Beef cattle and sheep		Total consumed	
	Cottonseed meal	Soybean meal	Cottonseed meal	Soybean meal	Cottonseed meal	Soybean meal
	1,000 tons		1,000 tons		1,000 tons	
1959-60	600	972	1,037	1,504	2,330	8,450
1960-61	577	1,381	1,135	960	2,498	8,837
1961-62	544	1,314	1,206	1,605	2,622	9,232
1962-63	573	1,454	1,206	1,846	2,585	9,556
1963-64	642	1,477	1,118	1,645	2,696	9,138
1964-65	616	1,534	1,183	1,862	2,680	9,236
1965-66	565	1,538	1,058	1,885	2,563	10,274
1966-67	375	1,506	569	2,114	1,755	10,820
1967-68	343	1,578	503	1,984	1,465	10,758

[1]Devers, Margaret, ERS-USDA personal communication.

there has been a reduction in the usage of cottonseed meal for both dairy cattle and beef cattle and sheep over the past 5 or 6 years. This is more than the difference in supply would account for. About 24 percent of the total consumed was used for dairy cattle in 1963-64 and about 23 percent in 1967-68. It might be said that this usage has remained constant. However, for the beef cattle and sheep 46 percent of the usage was for beef cattle and sheep in 1962-63 while only 34 percent was used for this purpose in 1967-68. While this was occurring, the consumption of soybean meal by these species remained relatively constant. As will be indicated later most of this difference was made up with urea. This will be discussed further later.

The non-ruminant market has been of interest to most producers of cottonseed meal. In table 3 we have presented the amounts of both cottonseed meal and soybean meal used in manufactured feeds for hens and pullets, for broilers and for turkeys. During the past five or six years the percentage of total cottonseed meal used in manufactured feeds has

Table 3. – Cottonseed meal and soybean meal consumed in feeds 1959-67[1]

Year	Hens and pullets		Broilers		Turkeys		Total consumed	
	Cottonseed meal	Soybean meal	Cottonseed meal	Soybean meal	Cottonseed meal	Soybean meal	Cottonseed meal	Soybean meal
	1,000 tons		1,000 tons		1,000 tons		1,000 tons	
1959-60	215	1,644	185	1,982	–	402	2,330	8,450
1960-61	225	1,400	200	2,059	–	706	2,498	8,837
1961-62	257	1,330	198	1,918	–	579	2,622	9,232
1962-63	250	1,333	229	1,991	–	613	2,585	9,556
1963-64	260	1,288	200	2,227	–	612	2,696	9,138
1964-65	256	1,304	200	2,209	–	555	2,680	9,236
1965-66	130	1,403	161	2,535	–	640	2,563	10,274
1966-67	125	1,290	150	2,700	135	495	1,755	10,820
1967-68	107	1,380	112	2,833	102	497	1,465	10,758

[1]Devers, Margaret, ERS-USDA personal communication.

increased for poultry. This increase has been from 18½ percent at the highest total available peak to 23 percent in 1967-68. However, it should be noted that the percentage of cottonseed meal has decreased from 9.66 to 7.1 percent and that use for broilers has decreased 8.7 to 7.6 percent. These decreases have occurred in spite of the fact that the National Cottonseed Products Association has supported work and publicized results showing that the effects of gossypol can be prevented to a large degree by the inclusion of iron salts in the ration. In addition, 50 percent protein cottonseed meal, with low gossypol content, has become available in certain sections of the country, notably the West Coast. One can only conjecture what the usage in cottonseed meal might have been had it not been for these developments. This has not occurred because of any lack of desire of the feed manufacturing industry to use cottonseed meal. I am convinced that it has occurred because the computer has enabled the feed formulator to make use of all of the information available on both cottonseed meal and competitive products. In many cases, as I suggested 2 years ago, the higher fiber content of the cottonseed meal with the resulting lower energy value has resulted in rejection of cottonseed meal in poultry formulas. It is interesting to note that usage for turkeys has more than made up the difference and this difference, despite an adverse court decision which awarded damages to a turkey grower because cottonseed meal had been used in the ration supplied by a very competent and reputable feed manufacturer.

The Research Committee of the National Cottonseed Products Association has encouraged and supported work to determine more realistic energy values for cottonseed meals produced by the various processes. If cottonseed meal is to compete for the poultry market and also for swine, we must have a glandless or low gossypol meal, low in fiber, preferably free, but certainly low, in mycotoxins, and processed with a minimum of heat to provide maximum availability of the amino acids. These are not high requirements. They are being met consistently by many processors of cottonseed meal and by your competition. The only real question is whether more of you, as processors, want to compete in this market.

In table 4 we have summarized the consumption by the various classes of animals, that is ruminants, swine, and poultry. The decreases in uses

Table 4. – Cottonseed meal and soybean meal consumed in feeds 1959-67[1]

Year	Total ruminants		Swine		Total poultry		Total consumed	
	Cottonseed meal	Soybean meal	Cottonseed meal	Soybean meal	Cottonseed meal	Soybean meal	Cottonseed meal	Soybean meal
	1,000 tons		1,000 tons		1,000 tons		1,000 tons	
1959-60	1,637	2,476	177	1,242	400	4,384	2,330	8,450
1960-61	1,712	2,341	245	1,738	425	4,537	2,498	8,837
1961-62	1,750	2,919	297	1,871	455	4.204	2,622	9,232
1962-63	1,779	3,300	198	1,708	479	4,292	2,585	9,556
1963-64	1,760	3,122	346	1,267	460	4,463	2,696	9,138
1964-65	1,799	3,396	296	1,147	456	4,387	2,680	9,236
1965-66	1,623	3,423	350	1,319	396	5,072	2,563	10,274
1966-67	944	3,620	175	1,421	505	4,951	1,755	10,820
1967-68	846	3,562	99	1,043	396	5,200	1,465	10,758

[1]Devers, Margaret, ERS-USDA personal communication.

for swine have undoubtedly been occasioned to some extent by some bad publicity received by the cottonseed meals and secondly, of course, the energy factor that I mentioned in connection with poultry. When we look at these figures, though, I would question some of them as would the people in the ERS who compiled them because of the erratic behavior of these statistics. However, the trend in the past 3 years has been very significant.

In table 5, we have presented the figures for the use of urea in manufactured feeds. The figure for beef includes the amounts used for sheep. I am sorry that we do not have figures for 1967 and particularly for 1968, because I think we would see a very decided

Table 5. – Urea used in formula feeds (U.S.) 1958-66[1]

Year	Total commercial formula feeds[2]	Urea included in formula feeds		
		Dairy	Beef[3]	Total
	1,000 tons	1,000 tons	1,000 tons	1,000 tons
1958	40,300	168	60	228
1959	40,300	168	73	240
1960	39,900	183	84	267
1961	44,700	196	90	286
1962	44,200	209	108	317
1963	44,400	207	124	331
1964	44,800	204	121	325
1965	45,200	207	122	329
1966	50,200	240	163	403

[1]Devers, Margaret, ERS-USDA personal communication.

[2]United States sales of commercial formula feeds based on estimates developed from American Feed Manufacturers Association data.

[3]Include some sheep feed.

increase in the amounts used. This is particularly true of 1968 when there were drastic reductions in the price of urea. This product is definitely the No. 1 competitor for oilseeds for the feed markets today. From a biological standpoint it can be used to replace all of the performed protein in the ration of the dairy or beef animal if a readily available source of energy and certain other minor nutrients are provided. We were successful some 12 or 13 years ago in feeding beef cattle rations in which the only sources of protein were the grains and the nonprotein nitrogen urea. This work has been repeated at other research institutions, and particularly and notably in Finland where Vertanin has maintained the dairy cow on an entirely synthetic ration.

When we look at the use of urea from the standpoint of the straight economics of feeding cattle, calculations made just a week ago showed a value of about $50.00 per ton for cottonseed meal when compared with urea, milo, and the necessary phosphate and other nutrients to equalize the two sources. Make no mistake – this is competition. As feeders become more skilled and lose their fear of using higher levels of urea, and as State feed laws permit use of higher levels, this type of compound will replace more and more of our oilseeds in ruminant rations. This applies to cottonseed meal, soybean meal, and sunflower meal, or other oilseed meals.

In spite of what I said about possibility of doing it, I do not forsee total replacement of the oilseeds with urea or other forms of nonprotein nitrogen in the near future – that is, in the period we are talking about today. However, I do expect to see it replace more and more of the oilseeds unless they can become competitive in price. Certainly at equal cost for the same amount of nutrition from cottonseed meal or ureas, both the feed manufacturer and the cattlemen are going to choose cottonseed meal. Cottonseed meal does have the advantage of being easier to handle, both physically and in pelletting. It does not have the disadvantage of rapid release of ammonia which, when not properly handled, can be toxic to the animal. These problems are inconsequential at low levels of feeding, but the gravity increases as the level of feeding increases. Obviously, much work is going on toward the solution of these problems. The premium over nutritional value that the cattleman or feed manufacturer will pay, then, will be very small at the low-use levels, but it will increase as the level of feeding increases.

Summing all of this up then, it would appear that the demand for cottonseed meal in animal feeds will become more and more restricted and at a lower price. The question, of course, is whether costs can be reduced to meet this type of price competition – that is, can cottonseed meal be produced and sold at approximately $50.00 per ton at a profit.

At the outset we said that there is a need for more and better supplies of protein worldwide for human consumption. Last year we discussed the types of products that might be made from cottonseed for industrial and edible uses. There seems to be real reason for optimism in expecting an increased demand for protein products on a worldwide basis. If we review some of the events in food production for the past 2 or 3 years just briefly, it is apparent that there have been some developments that are very encouraging.

The development of the new IR-8 rice at the Los Banos Research Station in the Philippines has provided a strain that will respond to fertilization without lodging and will increase the yields many-fold. This rice has been adapted to a number of the countries in the rice-bowl area. The Philippines have turned from a rice importing nation to a rice exporting nation. Other countries are rapidly approaching that stage.

A new and higher protein, higher yielding variety of wheat has been developed by Dr. Borlaug and his associates at the Research Station in Mexico. This wheat has adapted very well to the conditions in India and Pakistan. The yields in those two countries this past year, granted that they had favorable growing conditions and rainfall, has put both of those countries close to a self-sufficient basis from the standpoint of wheat production.

It seems to me, though, that the most important contribution that these two developments have made, in spite of the tremendous increase in yields, has been a psychological one. It has demonstrated that crops can be produced that will greatly increase yields and it has demonstrated that the use of fertilizers and other cultural practices do pay, and

that the local farmer can make a better living for himself and his family by adapting these new crops and new practices. And, almost universally, when these farmers see the results of these improved crops, they begin to think in terms of education for their children. This in turn means that the need for protein, as well as rice and wheat, will be recognized and that there will be an increase in demand for protein. This will be an effective demand rather than the figures of need which are so often quoted.

In many cases, the oilseed crops as we have them today cannot be grown in competition with the higher calorie cereal crops. This was the case in Indonesia, which we studied last spring, where it became very evident that the best solution to the problem of producting the protein needed would be to grow soybeans. An analysis of costs and returns indicated very clearly that the farmer could not afford to produce soybeans in competition with rice. Therefore, the protein must be imported. Now the question becomes, just what part can the cottonseed protein play in providing this needed protein? It must be recognized, at the outset, that the soybean is in the dominant position as far as protein for human use is concerned. Even in India where cotton has been produced as a primary crop, attention has been turning toward the production of soybeans. Research toward the use of soybean protein for human consumption and industrial use was started at least 20 years ago.

There is a reluctance to use cottonseed protein and an increasing interest in growing soybeans. I believe that the most important reason for this is the fact that the use of cottonseed protein for humans has been discouraged because of the presence of gossypol. More recently, the question of mycotoxins in cottonseed meal has been raised; but I do not believe that this has been a really significant factor in the failure to use cottonseed protein for human consumption.

When The Agency for International Development (AID) called upon the U. S. Department of Agriculture to produce a cheap, nutritious high protein supplement for free distribution in many areas, the product developed was CSM based upon corn, soybeans and milk. The reason was quite simple. Soybeans were available, cottonseed flour of known quality was not.

United Nations Children's Fund (UNICEF) has been ready, willing, and able to distribute some cottonseed-based products. To date they have been disappointed in the supplies forthcoming. Naturally, there is a reluctance on the part of processors to produce a product for giveway purposes. This can be a very fleeting and temporary market. However, if the cottonseed industry is to find out whether there is a place for it in the eventual export market, some means must be found to make the supplies available in quantity so that public agencies can justify their use in this type of product. They must also be high quality products so no questions can be raised regarding the judgment of our public officials in using them. Here again, the production of a glandless meal would certainly be beneficial. A glandless flour produced under sanitary conditions, free of mycotoxins, would certainly have some definite advantages in the diets for humans. The glandless flour is a bland product, and it does not have the problem of removing off flavors, which is necessary in soybean products. Cottonseed flours and isolates have solubility characteristics differing from those of soybean products. The cottonseed industry, if it chooses, can go further than that. Two methods have been developed at the Southern Regional Research Laboratory which will produce a very fine product analyzing approximately 70 percent protein. This is a type of concentrate that should serve a very useful purpose. I will not go into the processes here, because I think the people who are actually working with them will tell you something about them. At least I hope Mrs. Martinez and Mr. Vix will discuss these methods. Suffice it to say here that one of the processes is an air classification method and the other is a liquid cyclone method, both of which offer promise of being commercially feasible.

The outlook in the area of food use then is limited to prospects at this time. At present there is a very limited market and a very limited, if not nonexistent, supply of materials that would qualify for these purposes. Anything done in this area is based upon predictions and optimism. The alternative – to sit idly by, and watch other products take the market.

Turning to the domestic market, the only

product of which I am aware that has been competing in the human food market is Proflo. Several companies have been quite active in promoting soybean products in the domestic industrial and edible markets within the past few years. Soy protein has found a very definite place in the market for such products as paper coatings and adhesives. These proteins have very definite and well-defined characteristics. Other proteins displaying varying characteristics are needed to supplement those already in use. For industrial use, protein with varying degrees of viscosity, flowability, dispersability, and adhesiveness are needed. Up to this time, very little has been done to determine whether cottonseed protein isolates would fill any of these needs. Certainly this must be done. This is a growing industry. The use of photocopying machines and computers has certainly increased our output of paperwork tremendously. We can expect that this use is going to continue to expand as more and more reports are possible. The question that must be answered is whether cottonseed protein has a legitimate place in this field.

Turning to the edible market, there is little doubt that the effective demand for increased amounts of protein will be apparent in this country. The recognition that we, as a population, are overfed from the standpoint of calories, the recognition that we do not utilize fats as effectively with the sedentary type of life that we lead, will increase the demand for more products that are higher in protein and not top heavy in calories. Therefore, we can expect to see that more and more of our common dishes will be supplemented with protein, and most of this will be done with vegetable proteins. This is not to say that we will decrease our consumption of animal protein products. Far from it. The affluent portion of our society will increase the consumption of this type of food. Again, the emphasis for the protein for this type of use has been on the soybean. The question of the particular type of protein supplement that will be used in producing these foods will be determined largely by the functional qualities of those proteins, rather than by nutrition alone. Imbalances of the major amino acids can be corrected by the simple addition of the synthetic products. For example, soy protein can be made equivalent in nutritional value to casein by the addition of methionine. Cottonseed protein can be supplemented with lysine. Therefore, the functional properties will be the important determinant. This is not a large market when compared with the amount of meat, milk, or eggs consumed, but it is a growing market. We can expect that it will continue to grow. Here again, we must have information on cottonseed proteins, whether they be flour, concentrates, or isolates to determine their proper place in this competitive area. The National Cottonseed Products Association and the Cotton Producers Institute have supported work in this area. The work has been handicapped by the lack of a pilot plant to follow through on the wet processing methods.

While it is possible that a suitable concentrate and isolate might be prepared from the glanded varieties of cottonseed now available, the job would certainly be simplified and the costs would be decreased greatly if glandless cottonseed were available for this purpose. Here again, the question is whether the cottonseed industry is sufficiently interested in this market to get the work done.

To sum it all up then, it appears to me that we are faced with some very important decisions. We face a declining market in the livestock feeds and at a lower price. We do not know enough about the protein part of the cottonseed to know just where it can fit into the industrial and edible markets. We do know that the production of glandless cotton would greatly facilitate the work developing these products. It is going to take products made from glandless or very low gossypol seed for either animal or human use. If we are to go into the human area, upgrading of plants to meet human food standards will be required. This is not a bright outlook, from the standpoint of our traditional type of business. It does mean that there are opportunities ahead in other areas where better profit and more satisfying experiences should result.

FATS AND OILS–PRESENT AND FUTURE NEEDS

by

T. E. Doak
Lever Brothers Co.
New York, N.Y.

It is a particular pleasure to talk in New Orleans today about fats and oils for three reasons:

(1) This strangely quiet riverfront is normally the world's busiest commodity export center;

(2) I am in cottonseed oil country and cottonseed oil gave me by baptism in world trade 11 years ago; and last but not least,

(3) This meeting is under the joint sponsorship of two groups loosely classified as "business-oriented" – with a dash of "governmentalism" included.

The real keynote that I want to sound is that changes in the price spreads between the various kinds of fats and oils prompt you researchers and technologists to efforts that are at least equal in intensity to the day-to-day and season-to-season marketing efforts of the crushers and refiners. Furthermore, once one of these price spreads has prompted a research or technological "breakthrough," the price responses to production changes will never be the same as they were before.

The presence of Roy Davis on the panel leads me to reminisce for a moment to illustrate my point. In the early 1950's the cottonseed "package" support program generated tremendous Commodity Credit Corporation (CCC) stocks of cottonseed oil at prices too high for domestic use. These high prices prompted a research effort that made possible a sharply increased domestic usage of soybean oil in shortening and margarine. CCC stocks of cottonseed oil then became available at cut-rate prices abroad and a new German margarine based primarily on coconut and cottonseed oils was launched which soon dominated their consumer market. With CCC stocks gone by 1956, Germany turned to the U.S. open market and there was, to put it mildly, quite a bit of price steam being generated in the marketplace as many here may well remember. Then in the summer of 1957, with reduced cotton acreage evident, we asked the Germans whether alternative margarine formulas existed or could be developed. The answer was strongly in the negative. They had a truly excellent product and they simply couldn't duplicate the quality with other ingredients. They, in turn, asked us whether U.S. consumption could be shrunk from 1.4 billion pounds to 1.1 billion. We said it was barely possible a high cottonseed oil price could force a further shift to soybean oil in margarine, and to soybean oil, lard, and palm oil in shortenings, but high cottonseed oil prices couldn't displace salad oil demand. They didn't ask how high the price would have to go.

The consequent German buying program pushed cottonseed oil prices upward by more than 25 percent from August through January, with their tonnage requirements far from satisfied. It did lift cottonseed oil 4-1/2¢ per pound above peanut oil in Europe. All the way up, we kept asking if alternative formulas existed. The answer still was "no." Suddenly, in the middle of our buying program they said, "Don't buy, resell; we have found out how to make an equally good product with peanut oil." To complete the record, U.S. cottonseed oil prices collapsed–more from liquidation of speculative positions than from the actual tonnage resold. This now sounds like ancient history, but the message is clear: a short supply of cottonseed oil alone can never have the same price impact again. The researchers have narrowed the technological differences so that acceptable substitutes are available. Subsequently along came sunflowerseed oil as a third major alternative in substantial volume. Today, even with a fairly short supply of peanut oil in Europe, you are seeing only modest export demand for U.S. cottonseed oil–at prices that again are creating sterile stocks under CCC ownership. I should also add that domestic consumption won't bounce back much this season in

spite of a readily available supply. The "test tube boys" and the marketers (working under the short supply conditions of the past 2 years) have made further major inroads against cottonseed salad oil demand.

I hope I have demonstrated that there is close interaction, and reaction, between fats-oils prices and the technologies affecting the various possibilities for usage.

Fundamental Trends in Fats and Oils

I can only sketch some of the more sweeping parameters, past and present, that bring the 1968-69 oils situation into overall focus and thereby perhaps set some guidelines for the future.

Production. – 1. For complex reasons, countries other than the United States have increased their exports of competing fats and oils far faster than I ever expected. (World export volume for the edible fats and oils in 1968 was on the order of 19 billion pounds with the United States' share nearly 25 percent.) In fact, a few years ago I was a member of the school that thought the world by now would be utterly dependent on U.S. supplies. Today the school's signals have switched to "maybe by 1980." However, the United States is normally the residual supplier of the world, but our inability to export at prices below support levels has hampered foreign consumption of soybeans as well as the oils. This is providing a "price umbrella" or subsidy to foreign production and technological effort.

2. Russia made a production breakthrough with sunflower seed and emerged as a major world export competitor. They probably produced as much seed in 1968 as in 1967, but seem to have sharply altered sales strategy to try to avoid piling up Rotterdam stocks.

3. Along came fishing and fish oil to more than replace the decimated whaling industry. Fishing equipment is sharply improving, but the results are quite spotty this year with the water temperatures off Peru currently too warm to suit the fish. Herring fishing is also quite spotty for Norway and Iceland.

4. Palm oil is on the scene. The new plantations of fast-maturing, heavy-bearing trees in Malaysia and the Ivory Coast are generating production increases at a fantastic rate. Although palm oil is duty-free into the United States, the "unsaturated oil" trend limits the degree of competition here. Throughout the rest of the world competition will be fierce.

5. I should mention animal fats, with combined lard-edible tallow production having increased tremendously in Europe and elsewhere. The world's mountain of butter deserves especial mention.

6. My final production trend of the past decade is the spectacular growth of soybeans in this country and our inability the past 2 years to move these beans in national and international competition at anything like a corresponding rate. The result is a government forecast of "at least a 300 million bushel carry-out next September 1." It is clear that unless demand is stimulated or production is discouraged surpluses in subsequent years could become astronomical. As something of a footnote to the above, keep an eye on the "newer" oil-bearing seeds such as sunflower—the future trend is promising. However, I will willingly defer this subject to other scheduled panel speakers.

Government action. – 1. Tariff activity and international maneuvering because of opposing farm policies are both playing an increasing role in our marketing and pricing structures. The "Kennedy Round" import cuts will have major impact on our domestic price support programs—or our price supports will have adverse effect on the "Kennedy Round." (One can choose the perspective he likes best.) The "Mansholt Proposal" to tax Common Market imports of margarine ingredients would, if implemented, have major price repercussions in our markets as well as theirs. Price and, therefore, production patterns would be altered drastically.

A minor skirmish in our highly vocal "lard subsidy war" for the United Kingdom lard export market—the total volume potential at the moment appears minor.

2. Political turmoil has spasmodically disrupted supplies of palm oil, palm kernels, and copra from the Congo and Indonesia. Now the Nigerian production-distribution system for peanuts, palm oil, and palm kernels is in a shambles. The Congo hasn't made it nearly all the way back. Indonesia is making something of a comeback, but nobody can predict when anything approaching normalcy will return to Nigeria. The terms on which the war in Viet Nam is

ended could have major impact on the supplies of palm oil now coming out of Malaya.

3. We have already seen how cotton acreage restrictions, plus cottonseed price supports, set too high relative to soybeans, stimulated research efforts that resulted in soybean oil substitution formulations acceptable to the public. To up-date my recollections of 1957-58, we now have also seen the modified soybean oils make deep inroads into the demand for cottonseed salad oils in this country.

4. On the "demand" side, P. L. 480 has moved a lot of oils overseas. As a trend, government seems somewhat less inclined to appropriate money for food exports, or perhaps are finding less countries wanting to receive it. P. L. 480 oil volume has been extremely disappointing the past year and certainly doesn't promise to be dynamic this season. Such "gift" programs seldom appear to create steady cash demand for our products in future years.

Medical technology. – 1. I close this listing with the demand factor of the trend toward "polyunsaturated" fat and oil products (mostly a domestic factor at this point). To me as a "nonmedic", "nonchemist" layman, the main thrust of medical evidence and opinion seems to be that "polyunsaturated" products may aid in reducing chloresterol levels are likely to be increasingly linked to heart attacks or strokes or both. I cannot evaluate these arguments, but certainly research and marketing efforts in this country are intensely centered on products of this type. In this classification oils from corn, sunflower seed, and safflower seed oils rank in a "highly desirable" ingredient category, with oil from soybean also high but inhibited by flavor-reversion problems of its linolenic acid content. Cottonseed oil is a little further down this scale unless the oil is winterized. However, many products of roughly equivalent "polyunsaturated ratios" may be created from any of these oils. Lard, tallow, butter, palm oil, hardened fish oil, and olive oil fall by the wayside in such classifications. Certainly in this country shortenings have trended "softer," margarines have softened even more, and the trend increase in liquid oil consumption is outstanding.

Summary. – The net of all of these diverse factors is that the "test-tube men" have, in response to price stimulation, provided the world with an ever increasing supply of fats and oils. This trend continues to project upward at the same time that the different kinds of fats and oils are becoming closer and closer substitutes for one another. Thus, everything else being equal, a shortage of one particular fat or oil is not nearly so apt to cause the market price distortions we have witnessed in the past. Indeed the government becoming more involved on the demand side of our price equation, we can expect that they will, more and more, be the cause of future major price and production changes.

With this perspective behind us we can now turn to our current situation.

Current season fundamentals. – Price changes since end-September for fats and oils both here and abroad illustrate that broad trends are often disrupted by annual factors such as weather, political strife, changes in speculative attitudes, and labor turmoil:

Price changes since end-September

Soybean oil (Decatur)	+20
Soybean oil (CIF Europe)	+ 9
Cottonseed oil (Valley)	0
Lard (Chicago)	+43
Peanut oil (CIF Rotterdam)	+21
Sunflower seed oil (CIF Rotterdam)	+ 7
Rapeseed oil (CIF Rotterdam)	+15
Coconut oil (CIF Rotterdam)	+ 4
Palm oil (CIF Rotterdam)	+13
Fish oil (CIF Rotterdam)	+35

With the exceptions of U.S. cottonseed oil and world coconut oil, all prices show significant recovery from the physical gluts and psychological glooms that dominated markets last summer. There is no single, common cause, but there have been enough "newsworthy" items to generate more aggressive trade and speculative buying. As is characteristic of "news," some is baseless, some exaggerated, some factual, and some other news that cannot be evaluated for many months.

"World" influences. – During late summer Russia "withdrew" from the sunflower seed oil market with many figuring they had liquidated their

excess stocks and "knew" that the publicized drought would adversely affect 1968 production. The fact that Russia invaded Czechoslovakia 2 weeks later is a more logical explanation, because production turned out virtually unchanged (although Rumania and Bulgaria may have been cut). Actually, at no time did the Russians refuse to offer against specific consumer inquiry. It is also clear they have revised selling methods in various ways. Whether they will fully maintain last year's sales volume cannot be determined.

India's groundnut (peanut) crop was widely publicized as a failure. Facts are, of course, impossible to determine with accuracy but the degree of damage, in the opinion of the U.S. attache, was exaggerated and he expected a 4.6-5.0 OMM ton crop (in the shell) versus 5.84MM last year (a cut of 14 to 20 percent).

Supply availability of groundnuts (peanuts) is down in Nigeria, Senegal, and probably Gambia, with Argentina's poor crop of last year marketed early—hence the distinct price strength in Europe. It is no secret that this had generated limited export demand for U.S. cottonseed oil.

Acreage for new-crop Agentine is down but moisture conditions could permit a larger production.

Fishing, as I mentioned, has been distinctly spotty and stocks (still large) are being reduced. (Even with a price advance of 35 percent, keep in mind that fish oil is even now roughly only a 5¢ product in Europe.)

Palm oil is being absorbed well from origin, with consumers increasing both consumption and stocks. The United States is competing to a limited extent with Europe, because of the price discount relative to soybean oil.

Trying to project world (ex-U.S.) export availabilities (holding United States import and export demand constant with last season) and attempting to match these against world import needs, create a statistician's nightmare—the balance of hundreds of "guesstimates" gives a figure that must always be highly suspect. If this approach is used for this reason, I come up with a near balance of "availability" and "need"—perhaps on the deficit side by some 200MM pounds. These figures are certainly within the range of probable error—should they by chance be precise, stocks changes, or some moderate increase in soybean exports could fill the "gap." Even this, of course, creates a different market climate from a year ago when world stocks were still climbing.

Domestic influences. – The soybean/products complex presents a different type of problem. A record supply (from a record "carry-in" plus a record crop) makes for a sharply increased record "carry-out" regardless of demand increases.

Demand patterns are further complicated by the dock strike, which led to an early export surge for soybeans and meal, with mills now gradually "choking" on meal stocks accumulations as the strike persists.

Depressed prices for soybeans and high export demand for meal at harvest combined with speculative gloom to give cheap soybean oil. Use of the soybean loan was heavy and CCC, resale, and loan beans are now large enough in total to force market redemptions before the end of the season.

We are now in the reverse supply/demand situation where meal is a burden and oil production is reduced.

Domestic oil pipelines apparently were depleted on the summer price slide and domestic disappearance during October/December was phenomenal. Export volume also was good, primarily "old" P. L. 480 business with Pakistan and India (or a flying start at new-crop needs).

In the "post-strike" period (hopefully soon) soybean and meal prices could at least temporarily rally with the oil supply/demand balance altering sharply.

The season-long struggle looks like a range from stability to creeping strength for soybeans, with oil and meal jousting to see which product must (skimpily) finance the required crush. For the season as a whole, it isn't statistically clear to me which product must assume the burden, but I lean toward meal. I can only phrase my sentiments as a trader by observing that it's hard to create a "bull" and a "bear" out of two "dogs" – the demand for neither is really impressive or clear-cut – particularly as measured against crushing capacity.

Cottonseed oil. – Production should be nearly 1.4 billion pounds and domestic usage hard-pressed to reach 1.1 billion pounds, or up only a trifle from last season. I would be startled if "free dollar" exports could come close to absorbing the balance. CCC will

have brought about 100MM pounds by today, and, indeed, they could even be forced to take enough by April-May to restrict the residual "free supply" before the end of the season.

What CCC will do with their stocks is an "open-end" question – none of their alternatives appear attractive.

You can easily conclude from these observations that I have no strong convictions about the interplay in the market the balance of the season. It is at least a welcome respite from the trends I've previously described, but I cannot judge this situation as in any sense a reversal of any major trend.

Looking Further Ahead

Long-range projections are notoriously treacherous, but I am happy that I don't have to determine U.S. agricultural policy for oilseeds for the coming season, or the one beyond that. We appear to be in a mounting surplus situation, unless production can be retarded or market demands increased. "Status-quo" on price supports with decent weather will probably give us another major increase in stocks in one form or another. An increase in consumption is certainly preferable to a production cut, because production cuts provide only temporary relief and no permanent solutions.

I'm not about to claim that soybeans at $2.50 per bushel are enriching U.S. producers or that oil at 8-3/4¢ is inordinately high for the current line of consumer products at current volumes. However, I am saying that world competition is intense and on the increase.

What U.S. agriculture and industry face is increasing challenge rather than gloom or defeat. What we truly need is increased production but with demand increases that outpace production.

The first major challenge is to lick costs of production of oilseeds. The only logical way must be through increased yields. With average yields of soybeans rising steadily and the 100-bushel-per-acre barrier breached this year, I'm confident that a yield break-through for soybeans can be achieved. In certain areas perhaps sunflower seed can do even better.

Costs of processing, manufacturing, and distribution are other areas where even more progress needs to be made.

The world's population is rising and many already on earth, here as well as abroad, are malnourished or actually hungry. We must learn to produce – and distribute – foods worldwide much more efficiently. Those protein and fat foods need not even resemble any foods we know today, except as experimental prototypes.

The dairy cow is already obsolescent as a producer of anything but fluid milk and meat. The true economic values of butterfat and dried milk – or cheese – cannot support dairymen's costs of production. We're seeing dairy numbers diminish here and numbers must also diminish in Europe.

Technology can theoretically bypass the dairy cow entirely and create products from oilseeds that come reasonably close to duplicating fluid milk at a fraction of the cost of production. High distribution costs created by perishability and bulk can be slashed if such products are created. This could be one of the promising challenges for the oilseeds and foods industry – and you may need to hurry – remember that high-lysine corn may be just down the road as a threat to soybean and cottonseed meals as animal feeds. You may lose some more of your traditional demands. Also legislative barriers to such products are creeping into the picture.

Another area of challenge is in the field of truly acceptable meat substitutes and extenders. The world has always been short of meats for human feeding, partly because costs of production are high. Even efficiently fed livestock and poultry waste tremendous amounts of energy in converting feedstuffs into meat. Acceptable meat-type products at a fraction of the cost of meat can broaden consumption immeasurably while feeding the world better than it has ever been fed before.

We can never hope to increase the world's average purchasing power to the level at which the world's entire population can ever afford our present products at our present prices. The very affluent can still have their steak and fluid milk, but the mass of the world's people need tasty, palatable, nutritious foods at dirt-cheap prices. It is up to research to create these products, and it is up to business to tackle the marketing job. I can see no long-range reason for gloom in the oilseeds industry. Let's quit giving away high-cost products for which there are

not enough potential buyers. Let's create low-cost products that vast numbers can afford.

COTTON PRODUCTION – PRESENT AND FUTURE

by

R. B. Davis
Plains Cooperative Oil Mill
Lubbock, Texas

The relationship between cotton production and the cottonseed processing industry is simple and direct: The substantial production of cotton fiber as a textile raw material is an absolute necessity for the production of raw material for the cottonseed industry.

The recent past and the only slightly more comfortable present have driven this lesson home to us. Cotton production has been down, a result of planned programs to eliminate a burdensome surplus and some unplanned disastrous weather.

Cotton production this year is substantially higher than in the past two years and the outlook for next year is for further increase. The increase in fiber production means, of course, an increase in the supply of seed for the oil, meal, and chemical industry.

Cotton producers are united behind a program to expand cotton's market as a textile fiber. We now have our largest and strongest research and promotion program ever as a result of the larger 1968 crop. As production increased this year, it will make possible expanded promotion and research in 1970 and beyond. We know that cotton must be used if it is to be produced. And to be used, cotton must be competitive in price and quality as a textile or raw material. Fortunately, cotton is the most responsive of all fibers to modifications and improvements through research.

The production of cotton is equally responsive. Yields have increased from 300 to over 500 pounds per acre since 1948: Farmers have cut the man-hours required to produce a bale of cotton from 145 to less than 32 in the same period. In 1947, 99 percent of our crop was harvested by hand. Today, over 94 percent is harvested by machine. Any industry which can achieve that rate of progress with a minimum research program can certainly look forward with confidence to accelerating improvements in the future with an expanding research effort.

On our present cotton production, we have begun to come back. I doubt that an industry ever went through what the cotton industry has during the last 2 or 3 years, when the production was lowered by 45 to 50 percent. That is a pretty stiff reduction. It has had its repercussion in the markets. I know that when it became apparent in the summer of 1966, the refineries or the finished products plants had figured on it and the first thing you know the cottonseed oil business was in trouble. Pretty soon, as Tom said a while ago, you couldn't find that 100 percent cottonseed oil on the grocery shelves – it was a blend. We lost markets on cottonseed products and in cotton that I doubt we will ever get back. We just hope to be able to create some new ones. So, as I say, we have had quite a rough time.

I would like to talk to you a little about the future. You know, the question that has been asked me most in every level of life – producer, members of the Rotary Club, both here and abroad – was: What do you think the future is in American cotton? Well, it got me to studying over what I would say. The answer would depend on who I was talking to. If I was talking to a banker I would say that it was pretty good, keep the money coming. If I were talking to somebody that I thought was smart, then I would say that I wasn't too sure whether we had a good future in cotton or not. Sometimes when you look at it, as brought out here this morning, our total textile market has dropped to 43 percent and down about 5 or 6 percent this year, and in a market that was going up all the time – man-made fibers and especially rayon. They have had one of the best years ever and we have had one of the worst – not only here but abroad.

So, we begin to look into it and see. We all know the government subsidy, they are passing now to cotton producers. It is about $1 billion dollars per

year. The gins don't get it; the oil mills don't get it: but the producer has. Of course, since about a year before last, that billion dollars was just about half of the gross income on cotton and cottonseed.

Well, some people say that it is all right, but it isn't all right. It isn't the thing that you can build your oil mill on, or that you can build a gin on. Any time you do it on Government money, you are going to have a big disappointment, because the Government isn't going to be there sometime. It is very, very evident now that we are going to have limitations if the present program continues. When we do, we have just begun the trouble. What can we do to reassure ourselves of its future and reassure our cotton – both domestic and foreign? What can we do to lower the cost of production? If you talk to the grower, he says – nothing. He says that he can't produce cotton now as cheaply as the loan is. But really it is that subtle.

It reminds me of the story about the fellow out on the plain during the buffalo days. The first thing you know he is telling the story to his grandchildren – these buffaloes began charging in from every direction. He said that just before they got to him he climbed a tree. One of the grandchildren said that he had told them repeatedly that there were no trees there. He said, "Son, there had to be a tree there," I think that is probably the way it is with cotton production costs. It is going to have to be reduced – the cost of it, not only producing the cotton but the handling of it from there on.

I brought along a little box, just about the size of a lunch-pail. This box contains a full-grown stalk of cotton, fully loaded. I will open it up and show it to you.

This is a stalk of cotton, a full stalk cut off right at the ground late in the season at harvest. The remarkable thing about it is that this is one of 200,000 stalks of cotton to an acre, against about 30 to 40,000 normal growth of cotton. You will note that it just has three bolls on it. I have never seen one that had more than five, and quite often just two or three. The three bolls all look just exactly alike. The first crop was hailed out on the 20th of June. It was replanted the last days of June and made a bale of cotton to the acre. The micronaire or the maturity of it was 3.9. That shows what might be done. I repeat that it might be done because it may or may not work in your country. Since 1954 the experiment station has been growing what they call broadcast cotton – cotton planted in 10-inch rows. It has always produced at least 25 percent more than the cotton planted in normal rows.

In Australia, where they planted it in 8-inch rows, the average has been 30 percent and up.

It has things other than yield that would make it attractive. You will notice, as I have said, that these three bolls are about the same size. The fiber is a lot more uniform. You don't have bottom bolls and you don't have a long exposure for insects. If they save the first planting, it is all ready to harvest by the first of October. You can harvest it with a broadcast machine pretty much like a combine. It can be done cheaply.

Here is the best thing about it. The experiment stations will not tell how much it costs to produce it – all they say is less than 10 cents per pound. You talk to them a little bit more and they say 5, 6 or possibly 7 cents. This is out-of-pocket costs. This is not counting the value of the land and those things – but out-of-pocket costs. I believe that it can be produced for less than 10 cents per pound.

Now a good many people have seen this cotton and everybody from here to Japan is interested in the possibilities. I think the thing that attracted the most attention to foreign spinners when they came to Lubbock was that plot of broadcast cotton. They could see in it the possibility of our staying in the cotton business. They could see the possibility of our being competitive in the production of cotton.

As I say, they started it in 1954 and they were not interested because at that time there was no herbicide that would do the job. But now, all in the world that they do is to prepare the land. They plant it and the next time they go to the field they harvest it. It is just exactly like wheat, and it may have to come to that in cotton. I wouldn't point this out as being the answer at all, but I do point out that when we come to cutting costs it isn't going to be by leaving off one plowing and one treatment of insecticides. It is going to be a revolutionary cycle. This, or something else in combination, will make the cotton plant and will make the cotton harvestable. It will make everything so different that it just won't look like they were planted.

I have often said that I think cotton's greatest

liability is that it is an old crop with too many traditions, too many customs, too many friends, and too many of this, that, and the other. We never want to do the things that it takes to be competitive in the markets. We are either going to have to do it or, in my opinion, we are not going to be in business too long.

I would like to say one or two other things.

The other day I was attracted by a pamphlet – "Central Cotton Ginning." Now, the record shows, as presented by the Council meeting last week, where the costs of a bale of cotton between a farm in our country, South Plains, and the textile mills over here, is more than $60.00 per bale. The exports are a little bit higher than that. It is over 12¢ per pound in cost between the farmer and the textile mill. Now, how are you going to get the producers to cut their costs if we sit on our hands and let our costs go up year after year between the farm and mill? Incidentally, the cost of ginning has increased 50 percent since 1950. It is quite an attraction to me that there is just a possibility of central ginning.

It was said the other day at the Board Meeting of the Council that between now and next year we want every segment of the industry to say: What have we done? What do we plan to do to make your segment cheaper and better? This booklet may be the answer. This booklet points out that Russia on ginning, close to 7 million bales, had 120 gins which was between 50 to 60,000 bales per gin. Over here, I doubt that our gins will average 4,000 bales. I don't know anything other than a football stadium that costs so much and is used so little as cotton gins. Some way, somehow, we must lower our cost at every level.

The big thing in this will be: Will we agree to the change – keeping every bale of cotton separate from here to Japan under the producer's name and whatnot? Or, will the producers sell seed cotton and the blend made at the gin? The gin will run 6, 8, or 10 months out of the year. It will be packaged at the gin so that it could go anywhere and in anybody's market without further handling, without further sampling, and whatnot.

Those are some of the things that I think we are going to have to do for the future of cotton. My guess is that we can and will do them when we have to and I think that we are getting pretty close to the time when we will have to.

SESSION II: P. Page, Delta Oil Mill, Inc., Jonestown, Miss., Chairman

COTTONSEED MEAL CHARACTERISTICS REQUIRED FOR MONOGASTRIC ANIMAL FEEDING

by

G. A. Harper
National Cottonseed Products Assn.
Memphis, Tenn.

While cottonseed protein concentrates have been more commonly associated with protein supplementation of ruminant animals, a large volume of research and practical use experience demonstrates its dependable value as a protein source for poultry and swine. Because the nutritive requirements of poultry and swine and their tolerance for certain components of cottonseed meal differ from those of the ruminants and because cottonseed meals vary widely in characteristics, it is important to both cottonseed processor and monogastric animal feeder to give careful consideration to these characteristics. Thus, this paper will attempt to relate meal characteristics to monogastric animal performance on "practical-type" rations.

Many reviews have been published on this subject. Phelps' classical review **(33)** in 1966 was one of the most comprehensive, and it is recommended for further study. Frampton's review (13) concluded that cottonseed meals could be prepared which were equal to or better than toasted soybean meals in both growth rate and protein efficiency. He defined the ideal cottonseed meal as "100 percent of the original seed lysine is native in the meal; residual gossypol and gossypol derivatives in the meal are zero; residual crude oil in the meal is zero."

Frampton's ideal is hardly realistic on today's market, but the point should be strongly emphasized that (a) it provides an excellent objective to be realized at the earliest possible time, and (b) practical rations utilizing many available cottonseed meals as a significant portion of the ration can be formulated which produce near ideal results.

Among the dietary factors that relate to the efficiency of performance of monogastric animals are:

ENERGY
ESSENTIAL AMINO ACIDS AND TOTAL DIETARY PROTEIN
MINERALS
VITAMINS
FREEDOM FROM DELETERIOUS PHYSIOLOGICAL EFFECTS

Cottonseed meal use decisions should be related primarily to energy, dietary protein and essential amino acids, palatability or rate of feed intake, and freedom from danger of deleterious physiological effects.

The most commonly accepted standards for the nutrient requirements of poultry and swine are those published by the National Research Council of the National Academy of Sciences **(30, 31)**. This is a constantly evolving field of knowledge and various reviews and research reports will contain recommendations that depart somewhat from these NRC recommendations. These reviews include, but are not limited to, those of Jensen **(20)**, Thayer **(42)**, Waibel **(43)**, and Scott **(38)**. The nutritive requirements of monogastric animals vary with specie, age, and purpose for which the animal is fed. Generally, the younger the animal, the more critical are its requirements for essential nutrients and the less tolerant it is to physiologically active factors.

Although it may appear peculiar in a discussion of a protein concentrate, consideration first may be given to energy because it is the basic foundation of the diet. Primarily, the energy level of the ration is dependent upon the grain and fat ingredients but each major ingredient contributes to the total energy level and may otherwise affect the utilization of energy from other ingredients. Thus, the digestible

and metabolizable energy content of the protein source is important. The metabolizable energy values listed in table 1 were taken from tabulations published for use of those who employ computers to derive least cost rations.

Table 1. – Metabolizable energy values of some common feed ingredients (kcal/lb)

Feed ingredient	Source of data		
	Monsanto Co.[1]	Ark. Agr. Exten. Service[2]	Combs and Nott[3]
Animal fat	3,580	3,500	–
Barley	1,280	1,250	1,199
Corn, yellow ground	1,580	1,550	1,560
Milo, ground	1,480	1,530	1,518
Cottonseed meal, 43 percent	–	–	1,000
Cottonseed meal, 41 percent solubility	–	1,000	–
Cottonseed meal, 44 percent solubility	1,000	–	–
Cottonseed meal, 50 percent solubility	1,100	–	–
Soybean meal, 44 percent	1,020	1,020	1,000
Soybean meal, 50 percent	1,090	1,100	1,100
Fish meal, 60 percent	1,246	1,253	1,246
Meat meal	900	950	1,052

[1]Monsanto Company, Agricultural Division, Nutrition Management Service, St. Louis, Mo. Personal Communication, January 1969.

[2]Arkansas Agricultural Extension Service (2).

[3]Combs, G. F., and Nott, Hugh (7).

Hill and his associates[1] **(19)**, examined 11 cottonseed meal samples and found metabolizable energy values ranging from 770 to 1,300 kcal/lb as compared to a range of 1,050 to 1,350 in 20 samples of soybean meal. They reported that the higher fiber content of the cottonseed meals studied accounted for about 75 percent of the reduction in energy. It was also found that dietary levels of gossypol of 0.046 to 0.05 percent reduced metabolizable energy. Further, a relationship between nitrogen solubility in dilute alkali and metabolizable energy appeared to exist, but a meal with 74 percent protein solubility compared favorably with others having 86 to 94 percent solubility. This observation suggested to the workers that there may be a threshold for protein solubility in its effects upon energy value. The reports of Sibbald and others **(40)**, Baldini **(3)**, and Olson and others **(32)** suggest that protein quality may affect energy values. It is probable that cottonseed protein, which is insoluble in dilute alkali, is not well digested and thus its energy content is unavailable. Rojas **(36)** found a metabolizable energy value of 1,100 kcal/lb for a high-fat, screwpressed meal and 1,129 for a high-protein, low-fat glandless meal. His results for

[1] Hill, F. W., Lumijami, D. L., and Krabami, A. Personal communication. December 6, 1965.

prepress meals were within the range of values found by Hill. A most interesting observation reported by Rojas was that adding 600 p.p.m. of Fe to a 50-percent prepress solvent meal containing only 0.03 percent free gossypol had no effect upon metabolizable energy, but the same Fe supplementation of a 50-percent solvent meal containing 0.11 percent free gossypol increased metabolizable energy from 900 to 1,118 kcal/lb. Watts and Sasser (46) showed that additions of cottonseed hull bran served merely as a diluent when measured by broiler performance, thus opening the possibility of additions of fat to correct energy deficiency caused by high fiber meals. Sibbald and Slinger (39) found that acidulated vegetable soapstocks contained 3,530 kcal/lb as compared to 3,480 for feed grade tallow. Naber and Morgan (28) found a degossypolized solvent cottonseed meal, which replaced one-half of the soybean meal, maintained growth rate of chicks but feed efficiency declined. Addition of 4-percent cottonseed soapstock permitted feed conversion equal to that of the soybean meal ration.

Because cottonseed meal is fed as a source of protein, we need to be most concerned with its amino acid content and the availability of the essential amino acids, especially those that are most likely to be deficient in practical rations. Table 2 lists the ranges of amino acids found by Phelps in his review (33).

Table 2. – Amino acid content of commercial cottonseed meals (percent of meals "as fed")

Amino acids	Type of cottonseed meal			
	Screwpressed or expeller 41 pct. protein	Prepress solvent 41 pct. protein	Direct solvent 41 pct. protein	Prepress solvent 50 pct. protein
Arginine	4.0 to 4.5	4.0 to 4.5	4.0 to 4.5	4.5 to 5.0
Cystine	0.8 to 0.9	0.8 to 0.9	0.8 to 0.9	1.0
Glycine	2.0 to 2.1	2.0 to 2.1	2.0 to 2.1	2.2 to 2.5
Histidine	1.1	1.1	1.1	1.2 to 1.3
Isoleucine	1.5 to 1.7	1.5 to 1.7	1.5 to 1.7	1.8 to 1.9
Leucine	2.4 to 2.6	2.4 to 2.6	2.4 to 2.6	2.6 to 3.0
Lysine, total	1.6 to 1.8	1.6 to 1.8	1.6 to 1.8	2.0 to 2.2
Lysine, available	1.2 to 1.5	1.4 to 1.7	1.5 to 1.7	1.8 to 1.9
Methionine	0.6 to 0.7	0.6 to 0.7	0.6 to 0.7	0.8
Phenylalanine	2.2 to 2.5	2.2 to 2.5	2.2 to 2.5	2.5 to 3.0
Threonine	1.4 to 1.5	1.4 to 1.5	1.4 to 1.5	1.6 to 1.8
Tryptophan	0.6 to 0.7	1.6 to 0.7	0.6 to 0.7	0.6 to 0.8
Valine	2.0 to 2.1	2.0 to 2.1	2.0 to 2.1	1.8 to 2.3

Source: Phelps, Richard A. (33).

A very large volume of research, which space will not permit citing in this discussion, shows that lysine is the most seriously limiting amino acid in cottonseed protein. Various workers including Fisher (12) and Anderson and Warnick (1) have studied the amino acid adequacy of cottonseed protein by use of semipurified or low-protein diets. Such procedures are useful in determining the amino acid contribution made by the protein source, but caution must be observed in direct use of such results in determining the value of the meal in a practical ration containing several sources of natural ingredients. While Fisher and Anderson and Warnick found that under the conditions of their study cottonseed protein was deficient in isoleucine and threonine, Farr (11), using a chick ration of normal protein content and composed of natural ingredients, could obtain no response from supplementing with isoleucine and actually observed depressed performance with threonine supplementation. Watts (45) has very ably pointed out that while cottonseed meal is, by itself, deficient in lysine, methionine, leucine, threonine, and isoleucine, a ration based on corn and cottonseed meal, is deficient only in lysine and methionine. Figures 1 and 2, taken from Watts' paper graphically illustrate the point.

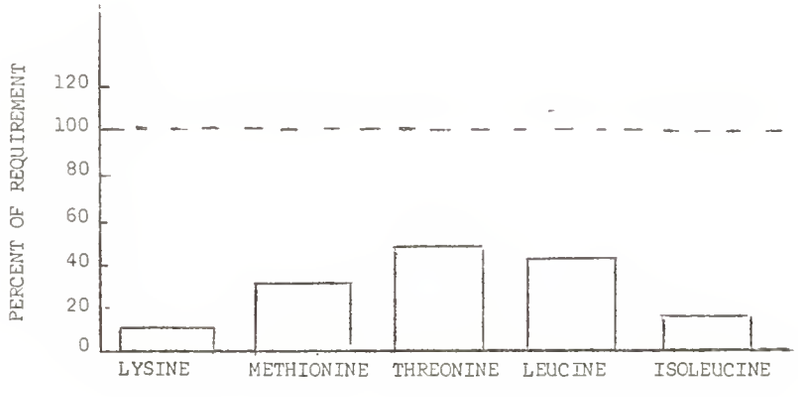

Figure 1. Amino acid contribution to ration by Corn (47).

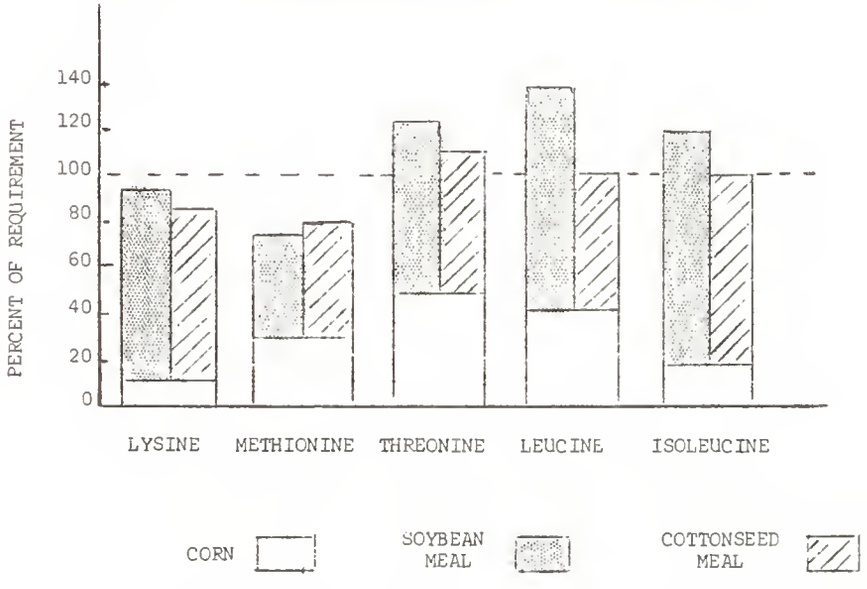

Figure 2. Amino acids contribution to ration (47).

From a practical standpoint it should be remembered that soybean protein contains less of the sulfur amino acids – methionine and cystine – than does cottonseed meal. It is common practice in feed formulation to add a methionine supplement to soybean meal rations. The same may be done with cottonseed meal rations, but the addition of small amounts of fish meal will adequately correct the deficiency of lysine and methionine. Phelps' review (33) cited extensive experimental proof of the equality or superiority of mixtures of cottonseed, soybean, and fish proteins over other combinations.

The wide variability of cottonseed meals in protein quality is well known. Protein quality reduction is highly correlated with the conditions of processing and the presence of pigment gland components. Frequent reference is made to bound gossypol and too frequently there is a poor understanding of "bound" or unavailable protein. In 1952 Kuiken (23) demonstrated that lysine, leucine, isoleucine, valine, threonine, and methionine availabilities were reduced by severe heating of gland-free meal in the presence of oil and gossypol or pigment glands. In a classical experiment, Martinez and others (27) demonstrated that the nutritive value of unheated, hexane extracted glandless protein could be drastically reduced by autoclaving. Also, after exhaustive extraction of sugars, the glandless protein could be greatly reduced in nutritive value by autoclaving with either or both gossypol and raffinose, the major simple carbohydrate in cottonseed.

Thus, for optimum use of cottonseed meal there is a need for measurement of the characteristics associated with reduced nutritive value for monogastric animals. Obviously, the best method of evaluation is that of performance of the animal under the conditions in which the meal will be fed. It is equally obvious that this is an impractical approach. Two chemical determinations have been proposed and both have appreciable correlation with nutritive value. Lyman and others (25) proposed measurements of protein quality by nitrogen solubility in 0.02N NaOH. Phelps' review led him to the conclusion that, on the whole, it does provide a valuable guide which has excellent correlation with animal performance at the higher and lower values. There appears to be less correlation at intermediate values and the method appears to be better adapted to prepress solvent meals than to certain other meals. Meals with a nitrogen solubility of 70 to 75 percent must be considered of good protein quality for monogastric animals.

While nitrogen solubility is an empirical index, measurement of protein quality by the amount of lysine with free epsilon amino groups (EAF lysine) may be reasoned to be more specific because this amino group is likely to be the most active point on the lysine molecule for reaction with other compounds which will result in rendering protein unavailable. Several methods (4, 8, 35) have been proposed and are based on the work of Sanger (37) and Carpenter and Ellinger (5). The ideal EAF lysine value would be about 4.2 g/16 gms N (percent of protein) since this is about the average level of total lysine in cottonseed protein. Mann and others (26) studied 19 commercial and experimental meals and found an almost straight line correlation between EAF lysine values and mean individual chick gains in feeding tests which placed extreme stress on single supplemental source, low-protein diets for baby chicks. The experimental meals with EAF lysine values from 3.98 to 4.36 g/16G N gave gains ranging from 290 to 374 grams. The commercial meals which were selected had EAF lysine values ranging from 1.58 to 3.68 g/16 G N and produced gains ranging from 116 to 290 grams. It is well to repeat that the conditions of the feeding test were not comparable to feeding practical rations and that it is possible to formulate rations which are adequately fortified so that the gains of some of the poorer meals will approach those of the better meals. Nevertheless it appears desirable to produce cottonseed meals for monogastric animals which have EAF lysine value in excess of 3.5 g/16 g of N. This can be achieved without undue difficulty in prepress solvent extraction and direct solvent extraction.

Gossypol has probably received undue emphasis in evaluation of cottonseed protein concentrates. Regardless, it is an undesirable component and the sooner it is removed completely from the meal the earlier will cottonseed meals be used in unrestricted amounts as a protein source in monogastric animal feeds. Smith and others (41) has reviewed the nutritional value of glandless cottonseed protein. The data reviewed justify the conclusion that glandless seed may be processed in commercial mills with no

more care than is given soybean processing into a protein concentrate which has value equal or superior to other protein concentrates in a practical, nutritionally balanced broiler ration. Johnston and Watts (21) found that glandless cottonseed processed in the laboratory under conditions simulating screw pressing and direct solvent extraction produced meals of nutritional value equal to soybean meal. Waldroup and others (44) fed a commercially produced solvent-extracted glandless meal in a practical ration and found that it was fully equal to soybean meal replaced at levels of 25, 50, and 75 percent. Performance was reduced at 100 percent replacement by equality was restored by supplementation with lysine at a level of 0.12 percent.

While gossypol is not toxic to animals with functioning rumen (10), it may retard growth of chicks at dietary levels between 0.016 and 0.06 percent (9, 17). Hale and others (14) proposed that the tolerance level for pigs is 0.01 percent in the ration. Several researchers reported (16, 29) that 0.02 percent free gossypol in the diet of laying hens affects feed consumption and egg production. It has been noted that pure gossypol did not affect egg weight or hatchability at a level of 0.012 percent of the hen ration, but depressed both at levels of 0.024 and 0.036 percent (18). Heywang (15) reported gossypol from raw meats and screw press cottonseed meal could affect yolk color of stored eggs at levels of 0.00025 to 0.01 percent. However, since that time it has been established (34) that cyclopropenoid fatty acids in these materials cause discoloration of stored shell eggs and intensify the effects of gossypol in causing olive yolk discoloration. Kemmerer and others (22) showed that ration levels of 0.2 percent cottonseed oil and 3 milligrams of gossypol, daily, did not increase the intensity of yolk color to an objectionable degree.

Bound gossypol is of significance because much of it has combined with protein to form compounds that are not digested by the monogastric animal. Lyman (24) showed that blocking the free epsilon amino group of lysine with gossypol reduced the liberation of other essential amino acids by trypsin. Subsequently, Cater (6) proposed the formation of gossypol-amino acid and gossypol-peptide complexes which helps to explain the reduction in the enzymatic digestibility of protein caused by the presence of bound gossypol.

The threshold levels of free gossypol in the ration may be used to determine what level of a specific cottonseed meal may be safely fed in a specific type of ration. For example, if the swine tolerance level proposed by Hale and others (14) of 0.01 percent free gossypol is accepted and a meal containing 0.04 percent free gossypol is used, it might be calculated that the ration might contain 25 percent of such a meal, which is well in excess of what might be used in most practical rations.

Tolerance levels of free gossypol are increased as either protein content or protein quality is increased (33). Also, ferrous sulfate has been shown to inactivate gossypol when this iron salt is included in the ration[2].

Available data (34) indicate that the cottonseed meal processor and the feeder need to consider cyclopropenoid fatty acids only when the meal is to be fed to laying hens. In that use it is desirable that the residual oil in the meal be reduced to the lowest practical level, preferably below the 1.0-percent level if the use is to be a substantial amount. For example, 10-percent of a solvent meal containing 1.0-percent residual oil would contribute a ration level of 0.1-percent cottonseed oil whereas only 2-1/2 percent of a screwpress meal containing 4.0-percent would contribute the same amount.

If one considers that cottonseed meal is primarily competing with soybean meal as a protein source in its use in monogastric feeds, it would appear that it is in a favorable position on mineral and vitamin composition. Table 3 gives the comparative values assigned by Combs and Nott of Maryland (7) and the Agricultural Extension Service of the University of Arkansas (2).

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2 Proc. Conf. on Inactivation of Gossypol with Mineral Salts, New Orleans, La., Apr. 4-5, 1966.

Table 3. – Mineral and vitamin composition of cottonseed and soybean meals.

Nutrient	Cottonseed meal		Soybean meal	
	41 pct.[1]	43 pct.[2]	44 pct.[1]	44 pct.[2]
Minerals				
Calcium, percent	0.15	0.15	0.32	0.60
Manganese, mg/lb	9.10	–	12.50	–
Magnesium, percent	–	0.62	–	0.27
Phosphorus, avail., percent	0.36	0.30	0.22	0.24
Potassium, percent	–	1.45	–	1.90
Zinc, mg/lb	26.00	–	11.00	–
Vitamins				
Biotin, mg/lb	–	0.50	–	0.15
Choline, mg/lb	1301.00	1300.00	1247.00	935.00
Folic acid, mg/lb	0.46	0.34	1.70	0.44
Niacin, mg/lb	20.70	20.70	12.20	12.20
Pantothemic acid, mg/lb	8.10	8.10	6.60	6.60
Pyridoxine, mg/lb	–	2.50	–	2.20
Riboflavin, mg/lb	2.10	2.10	1.50	1.00
Thiamin, mg/lb	–	3.70	–	3.00

[1]Arkansas Agricultural Extension Service, University of Arkansas (2).

[2]Combs, G. F., and Nott, Hugh (7).

SUMMARY

During the past two decades extensive research in the production and use of cottonseed meal in monogastric animal rations has created a vitally important outlet for this protein source. The characteristics of cottonseed meals have been elucidated to a degree which appears to justify greater use of this protein source. Understanding of these characteristics and their relationship to the total ration-fed monogastric animals is vital to (a) manufacture of cottonseed meals of optimum quality, and (b) proper formulation of feed mixtures containing cottonseed meals.

Cottonseed meal has been shown to be a desirable source of energy, total protein, essential amino acids, minerals, and vitamins. Obviously meal quality is dependent upon the type of cottonseed processed and the conditions of processing. Results from feeding commercially processed glandless seed indicate that such protein, when properly processed, can be substituted for soybean meal in highly significant amounts with equal or superior results in nutritionally balanced mixtures. Both glanded and glandless protein are susceptible to heat damage during processing, but glandless protein will be more tolerant to severe processing conditions. Gossypol and cyclopropenoid fatty acids are undesirable components of the cottonseed but their effects can be nil or minimal if recommended procedures are followed.

Cottonseed meals make their most productive contribution with greatest economy when treated as a part of a practical, nutritionally balanced mixture. Caution should be observed to insure appropriate use of experimental data obtained in experimental assays which do not meet the criteria of practical feed mixtures.

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COTTONSEED PROCESSING – PRESENT AND FUTURE

by

H. L. E. Vix and M. G. Lambou
Southern Utilization Research and Development Division
New Orleans, La.

(Presented by H. L. E. Vix)

My position on the program is exceedingly fortunate. This morning you heard Mr. Roy Davis give an excellent background and introduction to may talk, since cottonseed is, as you all know, geared to cotton. Garlon Harper added more specifically to this background by giving you some thoughts about the characteristics of cottonseed meal needed for monogastric animal feeding. I am also indebted to Dr. Wilcke, whose talk set the stage for my presentation. Each one has made my talk easier and, hopefully, shortened my remarks.

Now, what about cottonseed processing – present and future? Let me fill you in briefly. We all know that the cottonseed industry is at a crossroads now that some change is the order of the day. To stay in business these days an organization must be dynamic, growing, and headed toward a definite goal. The purpose of this paper is to have a look at the position of the cottonseed industry today, to discuss what we see in the immediate months to come, and project some possibilities for the future.

In the past generation hydraulic pressing has been phased out and the bulk of the seed produced is being processed by screw pressing, prepress solvent extraction, and direct solvent extraction. To broaden the raw material base, many mills process considerable tonnages of soybeans and, recently, some safflower, rapeseed, and sunflower. In many parts of the country, cottonseed meal of a high quality is being produced. Most of the former restrictions have been removed from feeding it to poultry and swine. A few of the mills have been automated and now require only minimum of labor.

As awareness of the importance of the world's total food supplies increases, proteins from all sources become critical. In this climate of urgent need the cottonseed industry has an eminently clear mandate to push ahead with the production of products suitable for human consumption. The big question which the industry must answer is – will its present technology and engineering permit industry to produce food grade products that can be mixed or blended with grains and other food materials?

To bring forth an answer, I have outlined convenience commercial meals and experimental meals and flours now known as follows:

LEGEND:	1	2	3	4	5	6	7	8	REMARKS
A. HYDRAULIC PRESS CASE	*		*						low free gossypol good N. solubility
B. DIRECT SOLVENT EXTRACTED MEAL			*		*	*			lighter in color than the hydraulic press cake product-good N. solubility lysine can be high
C. SCREWPRESSED FLOUR	*	*					*		low free gossypol-low total gossypol-good functional properties
D. PREPRESS SOLVENT EXTRACTED	*	*	*		*	*			low free gossypol-low total gossypol-high N. solubility-high lysine-least color of 1st four
E. ACETONE-HEXANE-WATER EXTRACTED MEAL	*	*	*	*	*		*		for feed purposes excellent (color and flavor problems for food)
F. LIQUID-CYCLONE-PROCESSED OUR FLOUR	*	*	*	*	*		*	*	(color not the best)
G. AIR-CLASSIFIED GLANDED FLOUR	*	*	*	*	*		*	*	(color not the best)
H. GLANDLESS MEAL OR FLOUR	*	*	*	*	*	*	*	*	rates best on all 8 items

LEGEND:

1.	LOW FREE GOSSYPOL	*	5.	HIGH EAF LYSINE	*
2.	LOW TOTAL GOSSYPOL	*	6.	LIGHT COLOR	*
3.	HIGH N. SOLUBILITY	*	7.	GOOD FUNCTIONALITY	*
4.	LOW OIL CONTENT	*	8.	ORGANOLEPTIC CHARACTER	*

Although we consider glandless cottonseed the ultimate, we want to emphasize that, over the years, we have seen the nutritive characteristics and functional properties of the meals improve significantly. The legend at the bottom lists the important nutritive characteristics and functional properties. An asterisk has been placed beside each property and a similar mark is transferred to the meal or flour if that property is acceptable in the product. The meals and flours are then rated as shown.

I believe the best commercial product being made is the prepress solvent extracted meal – it has a rating of 4-1/2 asterisks. It can be low in free gossypol and relatively low in total gossypol, good in nitrogen solubility, and fairly high in EAF (epsilon amino-free) lysine. It approaches more closely the experimental meals and flours that you see listed as Nos. 5 through 8. Of the experimental flours, glandless flour or meal is the best with a star for each of the important properties. The other experimental meals and flours have color problems as noted by the remarks in parentheses. There will be some attempts to use glanded cottonseed for food protein. So we can look forward to some progress with processes such as prepress solvent extraction, liquid classification, and air classification. The LCP-product from glanded cottonseed and flour from glandless seed are comparable from the standpoint that PER's (protein efficiency ratios), nitrogen solubility, and EAF lysines are equally high. These are in line with parallel characteristics of high grade AHW meals and flours.

The Southern Utilization Research and Development Division has recently published two papers on preparation of a liquid cyclone processed cottonseed flour which is suitable for human consumption. The process is unlike any now in use commercially, and yields an edible protein concentrate. The process depends upon liquid cyclones for the separation of intact pigment glands from the comminuted hexane slurried flakes. Smaller cyclones are used to concentrate the purified, gland-free fraction. The product, LCP-concentrate, is practically bland in flavor and has a light cream color. It contains 70 percent protein of 98 percent solubility, less than 1 percent lipids, not over 0.04 percent free gossypol, a 0.30 percent total gossypol, and an EAF lysine content of 3.85g. per 16g.N.

The liquid-cyclone-process for the production of essentially gland-free edible cottonseed concentrate from glanded cottonseed is envisioned as a part of a large plant that produces feed grade meal. It can be recommended as a feasible processing mechanism for the present. This process should be applicable for use by all mills already employing direct hexane extraction to produce feed grade meals. In the case of liquid classification, additional hardware would include that required for drying meats, for flakes comminution, screening, liquid cyclone separation, vacuum filtration, and final meal desolventization.

Preliminary estimates based on many experimental runs at SURDD have been translated to the theoretical operation of a plant porcessing 200 tons a day for 250 days per year. Using the liquid-cyclone-process, 1 day's operation would yield approximately 36.2 tons of high-protein concentrate, 31.0 tons of high-gossypol content meal, 36.0 tons of oil, 20 tons of linters, and 72.7 tons of hulls. For the purpose of this calculation, seed costs were estimated at $66 per ton and plant operating costs at $20 to $25 per ton (appreciably higher than that currently being reported for direct hexane solvent extraction plants). If current selling values of the products are estimated to be 12¢ per pound for the oil, 3¢ per pound for linters, 1.1¢ per pound for hulls, and 2 to 4¢ per pound for high-gossypol content meal, the break-even value of the high-protein concentrate can be estimated by difference to range from 4.7 to 7.6¢ per pound. **This product requires no additional processing to be classed as a concentrate.** If the break-even value is increased by only a few cents per pound to determine its selling price, an attractive profit on the daily per ton basis may be realized.

Some work at SURDD is underway to produce a product similar to that of the liquid cyclone processed cottonseed flour, by air classification of hexane extracted glanded cottonseed flakes. This product will be discussed by our next speaker, Mrs. Martinez.

On the basis of research conducted at SURDD it is recommended that:

(1) Any cottonseed product prepared for human consumption should be processed under optimum sanitary conditions that meet standards set by food processors and by government.

(2) Production of a good-grade flour should

be an integral part of a larger plant designed to produce feed-grade meal. For glanded cottonseed the high gossypol content fraction can be diverted to the meat stream of the second processing line used for the production of feed-grade material.

(3) Only prime, mature, sound cottonseed, free of contaminants, may be used.

(4) The product concentrate should have the following characteristics:
   (a) Low free and total gossypol content.
   (b) Protein quality equal to that of the original seed.
   (c) Residual lipids less than 1 percent.
   (d) Fiber content 3 percent or less.
   (e) Free of mold contaminants.
   (f) A protein content of 65 to 70 percent.
   (g) Acceptable odor and flavor.
   (h) Particle size, to pass a 200-mesh screen.
   (i) Very pale yellow color.
   (j) Free of solvents and solvent contaminants or decomposition products.

(5) Oil quality and yield should be maintained.

To realize the above properties, attention must be given to some changes in processing both glanded and glandless seed. Particular consideration must be given to storage of the seed, sorting, delintering, dehulling, preparation, extraction, desolventization, and grinding of the meal product. Especially important are the effects of moisture, temperature, and time on the protein quality of the meal because these variables may ultimately affect utilization as a flour, concentrate or isolate.

Opportunity for the cottonseed industry of the future lies in coordinating availability of glandless cottonseed with its processing under optimum sanitary conditions for the production of food grade products. Every effort must be made toward making such products available to the food industry. As outlined above, mills must abide by the sanitation regulations and application of all published research must be efficiently incorporated into the processing schedules where pertinent. I say this advisedly, because the stakes are enormous. Currently, some 200 million pounds of soybean products go into the food market annually and it would be less than realistic to feel that the cottonseed industry should not reach out for its share of this market.

What, then is the present status of glandless cottonseed? The National Cottonseed Products Association has diligently pursued the development of glandless cottonseed and followed its progress toward commercialization. Where feasible, funds have been made available and every conceivable assistance has been rendered in the special processing trials of this seed. Production and processing are still in the experimental stages, and it has become evident that much more coordination of effort must be exercised to attain the full potential. However, there would be a greatly increased interest and demand for high grade products for food, if these could by produced **now**. The word "now" is of utmost importance. Efforts are underway in many parts of the world to incorporate an edible grade cottonseed product into foods for feeding undernourished individuals. Considerable progress has been made and many children and adults are receiving the benefits of increased nutrition through the use of cottonseed flour and other vegetable flours. It must be pointed out that the cottonseed flour comes from glanded cottonseed and, therefore, there is still much room for improvement. Some prepress and screw press plants in the United States and in foreign countries are making meal products that come close to the standards set for human food. It cannot be overlooked that a substantial demand could be created if glandless products were available.

Not only do opportunities exist in the food field, but there is an excellent chance of making a higher grade feed material from glandless cottonseed. Both the food and feed products are interrelated and should not be considered individually. Their economics are interdependent. A sound economic basis can be attained only through the production of both types of products to meet the keen competition from other feed sources such as soybeans, urea, and others in the making.

All research in these areas are of utmost

importance and mill managers should watch every new report with diligence. Progress already made in research on processing glandless cottonseed has uncovered the excellent quality of the meal and oil, and some exploratory evaluations have made it evident that a high grade protein flour (60 percent protein from glandless cottonseed) will no doubt find use in many food formulations. Research and development work at SURDD on processing glandless cottonseed flaked meats by direct extraction with hexane has proved that it is possible to obtain a highly acceptable oil product while producing a flour product of high grade protein quality with acceptable color and flavor. Controlled desolventization of the marc must be conducted to obtain a white meal and flour product.

It is envisioned that economical commercial processes for glandless cottonseed can be engineered without serious difficulty, to produce products that fulfill all of the requirements cited above. It is predicted that widespread production of glandless cottonseed will provide substantial opportunities for the domestic cottonseed industry. Recently, investigations have shown that production of a protein concentrate (70 percent protein) from glandless cottonseed flour with commercial equipment by air classification will be commercially feasible. Mrs. Martinez will go into this in detail in her presentation.

Lipids are low and fiber and ash are similar to that for the liquid-cyclone-process flour. Work is underway at SURDD to determine the nutritive value and functional properties of flours, concentrates and isolates made from glandless cottonseed flour.

In recent cooperative work between the Cottonseed Products Research Laboratory at Texas A&M and SURDD, a better separation of whole meats and fine meats and hulls was obtained by retaining perhaps an extra 1 percent of the linters on the seed when delintering. The reason for this appears to be that the additional 1 percent of lint on the hull helps to keep the hull from fragmenting into small pieces. As a result, the whole meats are essentially hull-free; the fine meats not only contain less hull fragments, but these can be more easily removed.

Until now production of glandless cottonseed has been hampered by acts of Nature and unforeseen acts of man. Progress has been somewhat slow. I said before that the cottonseed industry had reached a crossroads. I would like to say it again, because it is time now for members of the industry to do some real soul searching and face up to their challenge with the courage and conviction that it is by their actions alone that realization of their full potential can be attained in the future.

Cottonseed meal has come a long way from the greenish, dark brown colored slab of hydraulic press cake to the attractive white bland flour from glandless cottonseed. Over the years, research in technology and engineering made many improvements in the processing of cottonseed. Through these improvements and the diligent efforts of the Mississippi Valley Oilseed Processors' Association, the National Cottonseed Products Association, and other trade organizations, much advancement has been made to achieve full utilization of the oil and meal products. In more recent years, nutrition work sponsored by SURDD has shown that these products are of outstanding high quality – highly nutritious. Yet, somehow, we are not now able to take advantage of this basic goodness. Some of our biggest competition in the near future besides urea will be the production of protein from petroleum, starch, and cellulose by the chemical industry, as well as fish protein.

I know that all of you are familiar with the Manhattan Project of World War II, Polaris of the early post-war years, and the Apollo space research which have culminated in such magnificant achievements recently. I don't know if you know that during research and development of Polaris, a whole new concept of management was born – this was called Program Evaluation and Review Technique, or PERT for short. This system is big and complicated, but that is no reason why we should not consider it here. For it permitted those who guided the research to know, at any point in time, if progress was satisfactory, where more resources were needed – manpower, supplies, equipment – in other words, they had their fingers on the pulse of the entire situation at all times. It is my opinion that we should be using such modern management techniques in agriculture – and especially to get glandless cottonseed flour on the market soon. It would mean that geneticists, who have already contributed so much to the glandless stock, would work hand in hand with farmers, ginners, crushers, chemists, engineers, machinery manufacturers, food processors, food technologists, statisticians, economists and marketing experts in one concerted effort to generate the

needed push to place this industry in the position it should rightfully enjoy. Other scientists are thinking in these terms. They view it with hope and see nothing impossible about it.

Toward this end, I would like to submit a prescription for action – by the industry and its associated organizations. Time is no longer on your side. The time for action is **now**. The most important thing that you can do is to pool your actions and efforts in a concerted attempt to better your position. With representatives of your Mississippi Valley Oilseed Processors' Association, the National Cottonseed Products Association, National Cotton Council of America, and other trade organizations, along with personnel from our Division (engineers, chemists), cooperating agricultural experiment stations such as Texas A&M, cotton and food technologists, economists, marketing people, statisticians, and anyone else whom you think can make a contribution, a **specific program of action should be drafted**. You, your industry associations, and our Government should be encouraged to finance and underwrite these efforts to stabilize the development of glandless cottonseed. You have already had one big breakthrough in the development of the glandless line. Now you need to pursue this windfall with all the vigor and vigilance necessary to realize firmly the full potential of the contributions that glandless cottonseed can make to the food industry.

Gentlemen, the time is ripe, the benefits **can** be realized, and the industry must act quickly to take advantage of the opportunity.

Let me leave you on this note – I strongly recommend that everyone connected with the industry join forces to secure the beachhead for glandless cottonseed **now**, because it is therein that the greatest growth potential for your industry lies. Let us realize the research-grand-slam that Garlon Harper predicted in 1962!

CHARACTERISTICS AND EVALUATION OF COTTONSEED FLOUR CONCENTRATES PREPARED BY AIR CLASSIFICATION

by

W. H. Martinez
Southern Utilization Research and Development Division
New Orleans, La.

Wilcke in his talk on "Proteins – Present and Future Trends" noted that one of the newer markets for cottonseed protein products could be food uses. This market, though presently small in volume, has the best growth and price return potential of any market the cottonseed industry might consider.

In this country, the major reason for the use of proteins in food is not nutrition. It is assumed, though not necessarily true, that we eat a sufficient quantity and variety of foods to provide adequate nutrition. The major reason for the use of proteins in foods is their functionality – the ability of the proteins to contribute in some measure to the finished quality of the food product.

The soy protein products, which are presently in the food market, range from a flour containing about 50 percent protein to an isolate of 90 or more percent protein. The protein in these products is the major determinant of the functional properties for which they are purchased. The other constituents of a defatted flour are, therefore, primarily diluents. In certain foods these other constituents may have no effect. In others, they may even be detrimental. Since the removal of these constituents is a cost factor, the removal of only as much as is necessary for the end product use is just common business sense. Therefore, in addition to the 50 and 90 percent protein products, you will find on the market today 60 and 70 percent protein products.

The subject of this discussion is the production of 70 percent protein products from cotton seed by the dry operation of air classification (4, 5). The work reported in this talk is the result of the collaborative study between the Engineering and Development Laboratory of the Northern Utilization Research and Development Division and the Oilseed Crops and Engineering and Development Laboratories of the Southern Utilization Research and Development Division.

As Dr. Altschul has pointed out to you before (1), the seed has already done part of the job. It has packaged the major portion of the proteins of the cell in specific sites called protein bodies. All that is necessary, therefore, is to break open the cell, shake loose the packages and separate them from the other particles and fragments.

The examination of a thin section of the cottonseed in the electron microscope (6) shows that the major particle in the cell is the protein body (1 to 20 microns in diameter) which is surrounded by a classical membrane. Within the protein body, small spheres can be seen which are called globoids. These globoids are the storage sites of the phytin phosphorus of the cell (3). Between the protein bodies, smaller particles (0.3 to 3 microns in diameter) called spherosomes can be seen. These particles are surrounded by a very dense membrane which is not solubilized during hexane extraction of the lipid. Both the protein bodies and the spherosomes are superimposed upon and embedded in the base cytoplasm which also contains the normal working machinery of the cell.

These then are the major particles in a pulverized meal: (1) The protein bodies, (2) the cell wall fragments, (3) residual spherosome membranes, (4) fragments of the base cytoplasm, and (5) clusters of cells. In the air classification procedure these particles are separated on the basis of their size, shape, and density, which are the factors governing the movement of particles in a stream of air.

In the laboratory, to evaluate the manner in which the particles will separate, a four-cut analytical profile is usually conducted. In this procedure, the variables within the air classifier are set to separate out only the very finest particles. After these are removed, the coarse fraction is reclassified with the air classifier set to accept a slightly larger particle. This procedure is repeated four times giving a

four-cut profile and a final coarse residue.

In table 1 are given the results of such four-cut analytical profiles of three hexane-extracted meals, two glanded, one glandless. These meals were ground in an Alpine 160-Z Kolloplex pin mill. The mass median diameter (MMD) indicates the particle size.

Table 1. – Selected characteristics of air-classified Cottenseed flour

	Weight			Mass median diameter			Nitrogen		
	133[1]	134[2]	132[3]	133	134	132	133	134	132
	Pct.	Pct.	Pct.				Pct.	Pct.	Pct.
Flour	100	100	100	12	13	15	9.7	9.7	10.7
Fraction									
1	31.4	28.8	31.9	8	8	8	11.0	11.1	12.1
2	18.1	17.6	19.2	10	11	11	10.7	10.8	11.4
3	23.9	26.3	26.7	15	16	16	9.6	9.2	10.2
4	10.2	10.8	10.2	18	20	19	8.8	8.5	9.6
5	16.4	16.5	12.0	63	47	56	6.8	6.8	7.5

[1]133 Glanded [2]134 Glanded-Tempered [3]132 Glandless

Note that the nitrogen content of the two finer fractions is higher than that of the original meal. These fractions contain a concentration of the protein bodies. The finest cut, Fraction 1, when viewed at low magnification under the light microscope appears as a rather uniform group of spheres. At higher magnification, the protein bodies with the globoid inclusions are readily apparent. In addition, there are a few small irregular shaped fragments. These are cell-wall fragments and residual spherosome membranes. The concentration of the nitrogen in these fine fractions is affected by the percent of these irregularly shaped, low-nitrogenous particles found in these fractions.

The nitrogen content of the third or middle fraction (table 1) is essentially the same as the original meal. This fact suggests that the fraction has a distribution of particles similar to that of the original flour.

In the fourth cut and final residue (fractions 4 and 5, table 1), the nitrogen content of the fractions is less than that of the original flour. These fractions must contain a higher percentage of cell wall fragments and other non-nitrogenous particles such as hulls. If the flour is glanded, the coarse residue also contains pigment glands and hulls.

The composition of the various fractions in the four-cut profile of the glandless flour in table 1 is given in table 2. Hulls were totally absent from this flour. They were completely removed from the meats before hexane extraction. The composition of the fractions, therefore, is due solely to the composition of the various cell fragments. Note that the nitrogen is concentrated at the expense of the lipid, the crude fiber, and the sugar constituents. These are the constituents that one would associate with the composition of the spherosome membranes and cell wall fragments. Note also that the phosphorus and the ash are concentrated with the nitrogen. This too is in keeping with the composition of the particles. The globoids, which are the inclusions in the protein bodies, constitute a large part of the phosphorus and ash of the flour.

Table 2. – Pertinent characteristics of air classified glandless cottonseed flour

Sample	MMD[1]	Yield	Composition dry weight					
			Nitrogen	Lipid	Ash	Phosphorus	Crude fiber	Sugar total
	μ	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Flour	15	100	10.73	0.88	7.84	2.16	2.2	7.33
Fraction								
1	8	31.9	12.10	0.48	9.03	2.67	1.5	4.09
2	11	19.2	11.38	0.37	8.46	2.33	1.9	4.42
3	16	26.7	10.22	0.54	7.41	2.02	2.7	8.84
4	19	10.2	9.56	0.75	6.75	1.78	3.1	9.48
5	56	12.0	7.50	1.84	5.35	1.24	3.5	13.14

[1]Mass median diameter, the diameter at which 50 percent of the weight of the sample is undersize.

Hulls are not a significant problem to the air classification process. If hulls are present, as in the first two flours from table 1, the hulls are concentrated in the coarsest fraction and final residue (fractions 4 and 5, fig. 1).

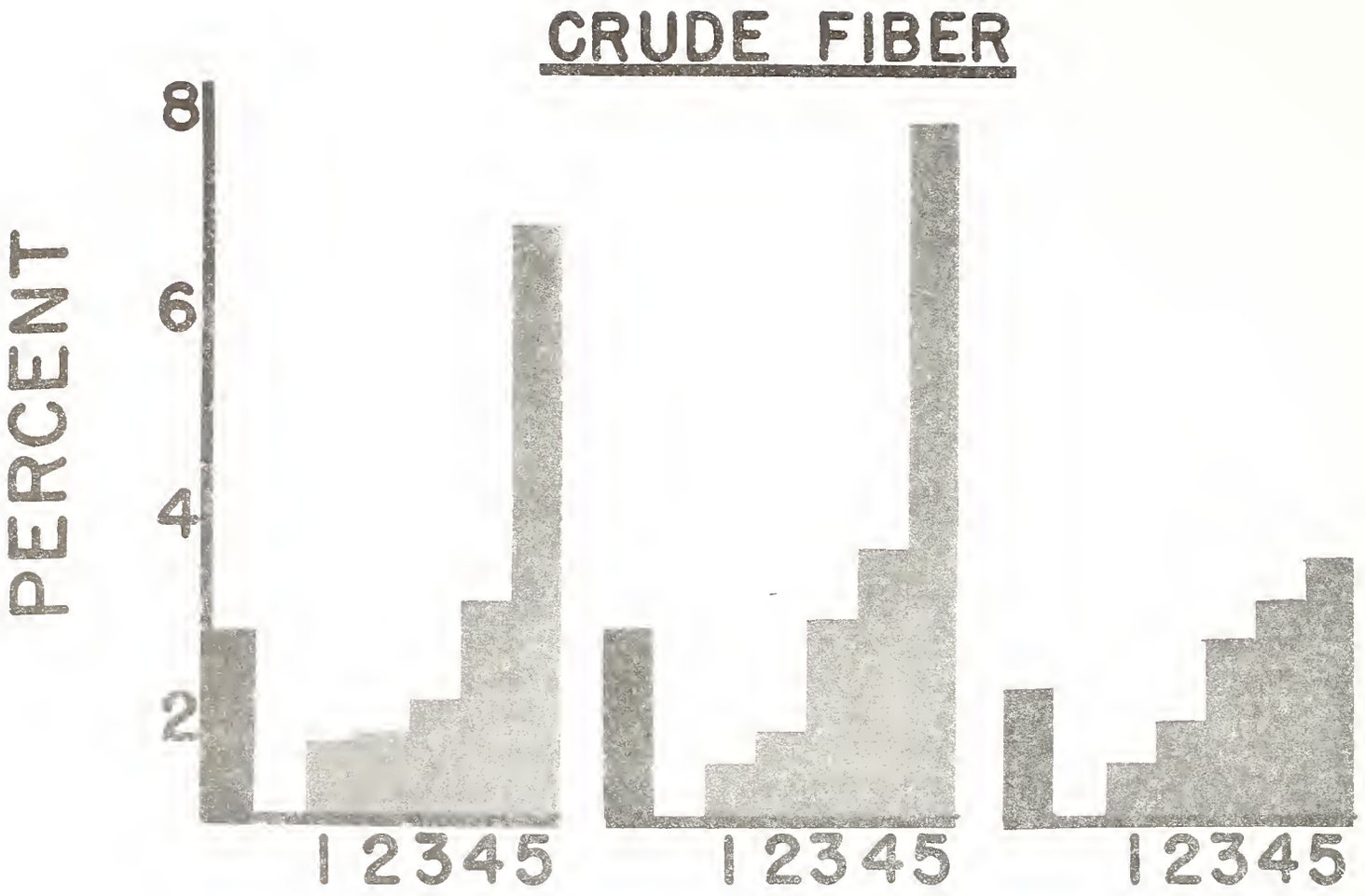

Figure 1. The crude fiber composition of five, air-classified fractions and the original flour for each of three cottonseed flours. Flour on the right did not contain hull particles (CM132).

The yield data in table 2 show that by a combination of fractions 1 and 2, 51 percent of the original flour could be obtained as a 73-percent protein concentrate (dry-weight basis). Actually in commercial practice only a single cut would be made to produce a fraction with an average particle size of about 12 to 15 microns. The process, produces, therefore, two products: (1) A protein concentrate for food use and (2) a coarse residue that is a feed material of high protein quality. This process, on the surface, appears very simple – dry grind and fractionate. There are, however, certain requirements. If the final product is to be a food product, then all operations, including seed storage and defatting, must be conducted under proper sanitary conditions. For good yield and concentration, the defatted meal must have a nitrogen solubility in 0.02N sodium hydroxide of 90 percent or better. This means that in the defatting operation the water-soluble proteins have not been solubilized and denatured to the extent that the protein bodies are glued in place. A good defatting operation would be solvent extraction, without prior cooking, with a form of desolventization which will not insolubilize the proteins, that is, no free steam.

The grinding is also important. What is needed is selective grinding, not total grinding to a single particle size (2). With selective grinding the constituent curves of a four-cut profile differ from the weight distribution curve in fig. 2. With fine grinding, there is no difference between weight and constituent curves and consequently no concentration of the nitrogen (fig. 3).

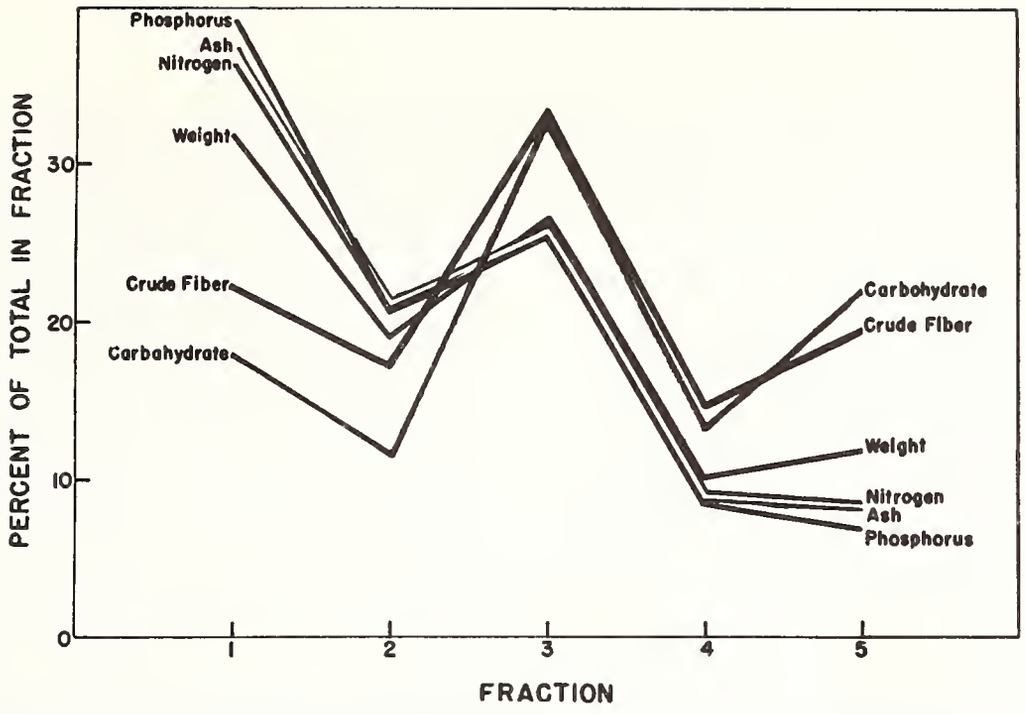

Figure 2. The constituent composition of each fraction of an air-classified, four-cut profile as a percentage of the composition of the original Kolloplexed glandless CM132.

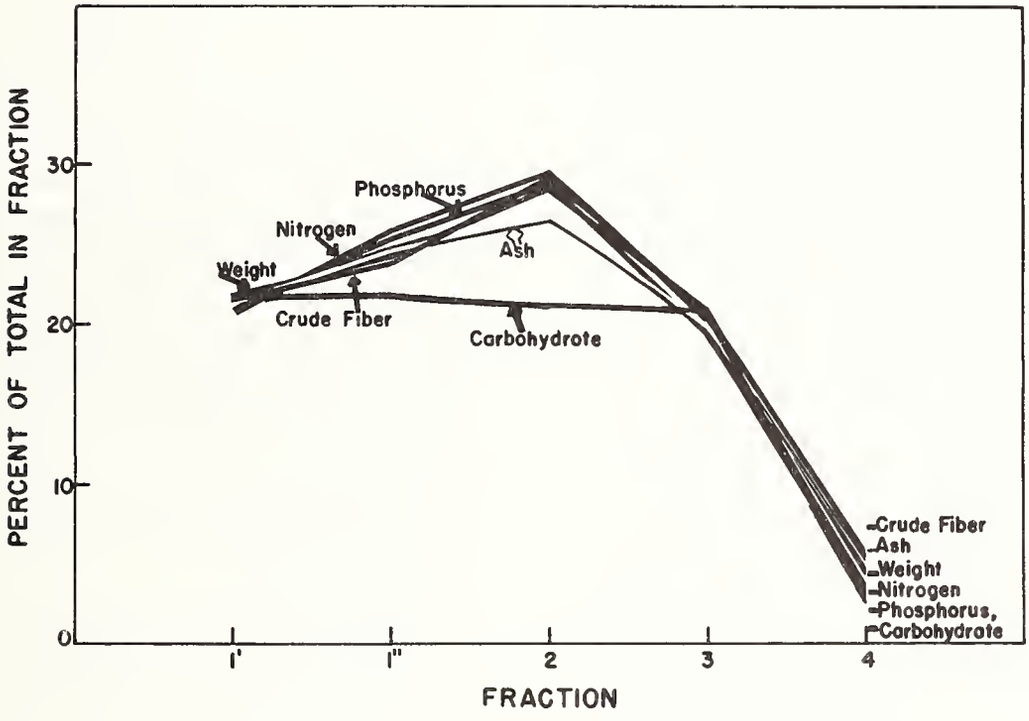

Figure 3. The constituent composition of each fraction of an air-classified, three-cut profile as a percentage of the composition of the original Turbomilled glandless flour CM132, Fraction 1 was reclassified at a finer cut point to give Fraction 1 and Fraction 1'.

Good selective grinding has been obtained with the Alpine pinmill. Pulverization in this unit is accomplished by the impact of particle against stud. The unit is air-cooled, and the major variable is the speed of the rotor. The pinmill is not, however, appropriate for glanded meals. The stud pulverization tends to fragment the pigment glands and produces small gosspol-containing particles that have similar air-classifying characteristics to the protein bodies.

In the Bauer Hurricane pulverizer or turbomill, the pulverization takes place by the impact of particle against particle and particle against rotor. This unit is also a very coarse classifier. The coarse hull content of a meal can be effectively reduced during grinding. The variables in this unit include the number of rotors, the speed of the rotors, the fan air, and the number of classifying fingers. Some measure of success was achieved with both glanded and glandless meals in this unit.

In the Majac pulverizer-classifier unit, pulverization occurs by impingement of particle against particle in a stream of air. Here the variables are the air pressure in the nozzles, the speed of the rotor, and the rate of the injector and strip air. The Majac unit has given promising results with glanded materials.

Two types of air classifiers have been investigated. In any air classifier the major variables are the speed of the rotor which accepts the fines and the velocity of the air stream through the unit. The Bauer unit is essentially the same as the Pillsbury unit. Both were designed by William Lickken. In these units the feed is introduced onto a dispersion rotor immediately above the "fine cut" acceptance rotor.

The Majac air classifier is the upper part of the pulverizer-classifier unit which, when separated, becomes a fine cut air classifier. In this unit the feed enters below the "fine cut" rotor. Therefore, a certain degree of classification can take place in the turbulent air flow as the fine particles rise to reach the rotor. Both the Bauer and Majac have provided acceptable separations.

As might be expected from the procedures involved in this process, the moisture content of the materials during the defatting, grinding, and air classifying are also significant variables. In general, a high moisture content during all these procedures gives a concentrate with a higher nitrogen content but in lower yield than that obtained using a low moisture content in all operations. A high residual lipid in the defatted meal will also affect the manner in which the meal pulverizes and air classifies. The presence of hulls, though not significant to the grinding and air classification will affect the yield of concentrate and nitrogen content of the final residue. These then are the major variables in the air classification process for the preparation of a protein concentrate: the defatting of the meal, the grinding, the air classification, and the moisture content in the materials during all these procedures.

We feel that this process has a number of advantages over the alcohol extraction process used in the soybean industry. The alcohol extraction procedure is a wet operation. Both the product and the byproduct – the alcohol solubles – must be dried. The alcohol must be recovered and the water solubles disposed of. In addition, the proteins of the concentrate are quite often denatured and new markets must be found for the byproduct. With the air classification process, two products are obtained, one an undenatured protein concentrate and the other a feed material of high protein quality and the fluid used is air.

In a recent test using a 58-percent-protein glandless flour and commercial pilot-plant equipment, 60 percent of the weight of the flour was obtained as a protein concentrate (69.4 percent protein, dry weight basis). The coarse residue representing 40 percent of the original weight contained 46 percent protein on an "as is" basis, that is, with a 58-percent protein flour (as is basis) we obtained a 60-40 split with 69.4 percent protein in the concentrate (dry weight basis) and 46 percent protein in the residue (as is basis).

One of the most important economic aspects of this process is the value that can be obtained for these products. What is the value of these products? How can they be used?

We know that there is a small but significant difference between the basic amino acid composition of the protein concentrate and the original flour. The lysine content is slightly less (4.0 vs. 4.3 g./16 g.N) and the arginine is slightly higher (12.8 vs. 12.0, g./16 g.N). These shifts are in agreement with our knowledge of the amino acid composition of the protein body proteins. One might expect, therefore, that the coarse residue would be slightly higher in lysine and

correspondingly higher in nutritive value. This is exactly what we find. Evaluation of the protein efficiency rations (PER) by the Ralston Purina Company showed in three trials with three different meals that the coarse residue was as good or better than the original flours. Though the PER ratios were numerically greater for the residues, they were not significantly greater at the 5-percent level. The numerical value for the concentrate was also consistently but not significantly lower (at the 5-percent level) than the original meal. These meals were hexane-extracted, air-desolventized, undenatured, glandless meals. In two of the three trials, the meals and the air-classified residues had PER ratios equal, significantly, to the standard casein at 2.50. If one compares this value of 2.50 with the value of 1.48, which was obtained for a high-quality prepress solvent meal, the true nutritive potential of the undenatured cottonseed flour and the air-classified residue becomes readily apparent. If, however, the coarse residue were from a glanded flour, it would be necessary, because of the whole gossypol-containing pigment glands, to either restrict the use of the product to ruminant feeds or to do further processing which would no doubt reduce the excellent protein quality.

The flavor profile of the glandless air-classified concentrate has been conducted by two companies. Both agreed that the concentrate had a low moderate flavor profile without any note of a soy-type flavor.

By means of a contract with the American Institute of Baking, the functional characteristics of both the glandless flour and concentrate in bread have been evaluated. The flour was substituted in the bread formulation at the same level as the nonfat dry milk control (NFDM) – 3 percent. The concentrate was used at a level (2.6 percent) equal in nitrogen content to the flour. With the addition of 30 p.p.m. of additional bromate to the formulation containing cottonseed products, no significant difference from the NFDM control could be found in any characteristic measured by the baking institute.

Neither was there any difference noted between the 57-percent protein cottonseed flour (as is basis) at the 3-percent level, and the 67-percent protein concentrate (as is basis), at the 2.6-percent level. For use in bread formulations, therefore, the economics of the flour and concentrate production would be the determining factor.

We have also had several comments from the food industry concerning their own unspecified use of the glandless concentrate. They have stated that the glandless concentrate performed better than any other vegetable protein concentrate. This means, in most cases, better than soy.

With the air-classification process, therefore, we feel that we have a process which is relatively simple, is economically feasible, has certain advantages over other concentrate processes and in addition, produces two products of high quality, one for food and one for feed.

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THE FOOD AND DRUG PERSPECTIVE OF THE OILSEED PROCESSING INDUSTRY

by

E. L. Holmes
American Sanitation Institute
St. Louis, Mo.

There is a good deal of misunderstanding, which I will try to straighten out in the oil seed industry and in the cottonseed products industry, as to responsibilities under the Food and Drug Act. This is probably because of the history of Food and Drug legislation.

In 1906 Congress passed a Food and Drug Law which required that products not be adulterated. In 1938 Congress passed another Law which went a little further, and I think that it is of interest to review this very briefly.

As all of you know, to ship any product in interstate commerce that has been adulterated is a violation of the Food and Drug Law. The question is: How do we define adulteration? The Law of 1938, under which we are operating today, has two clauses, one of which is identical almost with one in the old Law. It is Section 402(a)3 that reads: "A food shall be deemed to be adulterated if it consists in whole or in part of any filthy, putrid, or decomposed substance or which is otherwise unfit for food."

A great many people in this industry, particularly those primarily interested in producing edible oils have taken the position, rightly or wrongly, that they are producing a product that is subsequently purified to such an extent that it doesn't matter too much how they produce it in a crude oil state.

Section 402(a)4, the succeeding paragraph, which only came into existence with this Law of 1938, states: "A food shall be deemed to be adulterated if it has been prepared, packed, or held under unsanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health."

Here is the joker. What is meant by this clause – "whereby it may?" This is a clause that was put into the Law to provide for just such contingencies where a food product, during the course of manufacture, may be contaminated, but then subsequently, in part, refined to the point that you cannot demonstrate the contamination by analytical processes. Such, of course, is the case in cottonseed oil or in other edible oils. This is basically an inspection law now. It provides that the Government may send an inspector to your plant. If he notes conditions that may contaminate the product, you can be prosecuted or the product may be seized, or the plant may be enjoined, if he can determine sufficient poor practices or situations within the plant, that within the mind of the Government, the FDA attorneys, and the U. S. attorneys, may contaminate the product.

You may well ask: "Has this ever happened?" A lot of people in the food industry think that it never has because wherever possible the Government does try to corroborate such findings by analytical findings. But I can assure you that in many instances they have prosecuted entirely on evidence by inspection.

What does all this mean? I can't give you a full lesson in law in the very brief time available. We could talk for hours and days on the subject of this law alone. But very briefly, I think that those of you who are in the edible oil business need to know what your problems are in this regard.

For a single violation of the law for the first time, one is subject to $1,000 fine per count and a year in jail. For a repeated violation or a serious violation – one that is premeditated – one is subject to a $10,000 fine, or 3 years in jail for each count. This almost makes a felony. You might ask: "Who is going to jail? A corporation can't go to jail." This has been all thrashed out in the Courts; however, I can't, unfortunately, take the time to cite the actual cases to you.

The result was that the responsible officers, responsible directing personnel, and any other responsible individuals can be held personally answerable. Under the law today, whenever an action is taken, almost invariably a citation for subsequent

prosecution is issued, not only to the firm involved, but generally speaking to the manager of the individual plants concerned. This could also include the Superintendent or even lesser personnel who are really involved. These are the unfortunate gentlemen that might go to jail and quite a number have. Usually they are put on probation, but this can be embarrassing. Just remember that if you violate this Federal Food and Drug Act you can possibly be held guilty of violating a Federal Law, which is a criminal law and not a civil law, as this is not a civil action but a criminal action. You can be arrested and you can be fingerprinted, taken down to the Marshal's Office, and subsequently be put on probation and have to report to the Probation Officer. You would not be allowed to go out of the State without getting his permission. All of these things add up and it is a lot of trouble and a serious proposition. It is not something that should be taken lightly.

Action under this Law is not static. When I was Chief Inspector of the Atlanta office of the Food and Drug Administration from 1938 to 1942, our annual budget was something like half a million dollars. Since then, the budget has been increased considerably as I will show you in a moment. There has been greater and more widespread recognition of the need for sanitation improvement in food plants generally.

Briefly, I will give you a few figures. I left the Food and Drug Administration in 1945, and I suppose by that time they had an appropriation of about 1-1/2 million dollars. By 1958, there was $9,300,000. In 1968 they are now getting an appropriation of 70 million. This is the reason for increased activities. There are more inspectors, more analysts, and more field officers, and they are generally in a better position to cover the food industry than they have been.

One of the subjects that is important to you is that when one of these inspections is made, it is not made in a casual manner. It is a serious proposition and you must bear this in mind by setting up a definite procedure in your plant of what to do when a Food and Drug inspection is made. First of all, you must always accompany the inspector. You have no idea of the things he may find out if you don't. The major reason for accompanying the inspector is to keep him from pumping the employees that you have. I don't know how many of you realize it, but you may have a lot of irate people in your employ who have personal gripes for some reason or other. When they can get hold of an inspector making an inspection, if they don't see the boss looking they may tell him anything. When I was Chief Inspector we were anxious to enlarge the scope of our activities and our techniques and one of the first things that we discovered was just this. Therefore, when we sent our people out, they were given instructions to sit down with the employees and see if they could find what the attitude of the employees was in this particular plant. You would be surprised the things that an inspector is told. Sometimes this is done on a gripe basis and sometimes it is done on the basis of general and genuine interest. But, if somebody in authority accompanies the inspector, this automatically alleviates much of this problem as he can avoid letting the inspector contact the wrong people.

If things have gone wrong and there are areas that obviously need cleaning that have not been cleaned, they should be corrected immediately. This will alleviate the necessity of the inspector putting on his report that apparently management has not cooperated as they have been asked to.

I'm going to give you a good example of what I am talking about, and it is always nice to talk about other industries in this regard. I can remember a margarine company that got into trouble, serious trouble, and they deserved it too. They had a situation where they were holding tanks in a room in a rather old structure that had an overhead ceiling which was a harbor for cockroaches, that should not have been there. For some reason, an occasional cockroach would drop down from the ceiling into the milk tank. One day a Government inspector was present and saw four or five roaches floating around in this milk which was to be turned into the oil going into the margarine. The obvious thing to have done would have been for the plant to have immediately drained the milk and thrown it into the sewer. They did not do this. A decision had to be made by the Administration as to whether to prosecute this company or not. They were a very reputable company. This certainly wasn't going to happen again, but it was decided to prosecute them solely on the basis of their not doing something to correct the condition at the time. They went ahead and used this evidence. Now, I'm sure the idea of having margarine

that has been churned into milk with cockroaches floating in it doesn't appeal to you, and I think you will agree that the Government was justified.

If you have similar situations in your plant, I would suggest that you make a definite plan during your inspection to initiate whatever corrections are necessary immediately. If any infested or pest-ridden material is found, then have it destroyed. If the inspectors find some corner of the cottonseed mill plant where there is an accumulation of stuff that is insect-infested and they comment on it, don't ignore it. Get somebody with a bucket and a shovel and a vacuum cleaner and clean it up right away.

If the inspector collects samples, obviously it would be very foolish not to collect duplicate samples. These samples which they collect during an inspection are not regulatory samples. They are not the samples that they bring action against, they are evidence. They are collected for the purpose of substantiating what the inspector says. If he says that you have bugs in a stored ingredient in your plant, he tries to substantiate it by returning to the office with a little jar of the material with bugs in it and he reports that this is what he picked up during the inspection. Well, obviously, if you agree with his finding you would want to destroy the ingredient. But, if he picks up something that you think is not adulterated to take back to run for fragments or something of that sort, then you want to be sure that you have a duplicate sample so that you will have something to base your position on in the controversy.

One must recognize the significance of a Form 483. This is technical nomenclature, but when the Law was first passed in 1906, they had no authority whatsoever – everything was voluntary. If you wanted to, you didn't have to let a Food and Drug inspector in your plant. Personally, I have been chased out of a plant by an irate gentleman with a pistol. He told me to get out of there, or he would blow my brains out.

But, when the new Law was passed in 1938, section 704 states that it is a violation of the Law on your part if you do not permit an inspector to make an inspection. Now, to some people, this seems like a violation of their Constitutional rights. There was a considerable controversy aroused and this was rectified.

Those in opposition contended in court and won, that it was necessary under these circumstances for the Government making what amounts to a search and seizure to at least request permission if they were going to be held responsible. Now, FDA inspectors have to request permission and this is done by a Form 482. It was also held that when they got through, they had to tell you what was wrong. So that was put into the Law and we call this the Form 483. This is simply a scrap of paper with a blank on the top where they put in your name with a little insignificant line at the bottom that says it is Form 483. Usually the conditions are spelled out in longhand and it doesn't look like anything, but the inspector is required to list a complete account of exactly what he found wrong with regard to the sanitation of this plant. People who get into trouble with the Government and are subsequently prosecuted sometimes come to us for help. Of course, we are pretty good at going – not to the Court – but to the Government offices and talking this over with them and explaining the situation and trying to prove things and help get them off so that they don't get prosecuted.

When I get a call from a man in the oil mill who says, "Could you get somebody to come by and see us? I think that we would like to talk with you about the consultant work that you do," I smile to myself and I ask him over the phone if he has recently been inspected by the Government. He will often say, "Well, how did you know?" I will say, "Well, it usually follows." Then he won't know what I am talking about, though I will say, "Did he leave one of those hand-written sheets?" Sometimes he will say, "Oh, yes, I have that filed away in my desk drawer, but I haven't really looked at it, I didn't really know that it meant anything." Sometimes, if he is the Manager, he will say, "No, I didn't get anything like that, let me ask the Superintendent." So he will ask the Superintendent, and he will find that the Superintendent has it filed somewhere in his desk. It may be filed in File 13, which is the wastebasket. This, however, is an extremely significant form as it tells you exactly what you are faced with.

A lot has happened in recent years. I had this Form 402(a)4 before you a moment ago and I read the following to you – "A product is adulterated if it has been prepared under conditions which may contaminate the product itself."

Years ago the question came up: What in the world does this word mean. What is filth? The question asked by the Government was: What shall we do about this? How are we going to get these people to do something? Obviously, they have to be prosecuted but on what basis are we going to prosecute them? The best index available to indicate that a product might be contaminated with filth was to show the presence of vermin and pests in the plant – rats, mice, cockroaches, and, depending upon the industry, all types of insects. In the cottonseed mill business you are afflicted with the same type of insects that the bakers are.

The famous Court decision that settled this question once and for all held that this meant a product contaminated with filth or likely to be contaminated with filth or involved anything that would be repugnant to the consumer – so for years and years this was the total basis of action under the Food and Drug Law. In recent years there has been quite a change involved with the Food and Drug's thinking. We have had several new Commissioners with various backgrounds, and they have been more concerned with disease and the spread of disease through contaminated foods. Therefore, the pendulum has swung over to the side of bacteria, food-handling, food practices, and processes in a plant and general cleanup. Let me assure you that the basic source of most bacterial contamination, in my opinion, comes from rats, mice, and cockroaches in the plant rather than from the ingredients being contaminated before reaching the plant.

There are other factors also and it was decided that this was not clear to industry. Of course, I am giving you my opinion and somebody from Food and Drug might give you a different opinion, but I am trying to be very down to earth with you. In my opinion, they wanted to make it more detailed and they wanted to do for the food industry what they have done for the drug industry. Sometime ago a Section was passed in connection with the drug industry. This grew out of some gross violations that should never have occurred but did, out of carelessness, whereby the Government has the authority under the Law to lay down what they call Good Manufacturing Practices in a drug firm. I have forgotten the number of the Section, but it has nothing to do with food whatsoever.

When these gentlemen with a medical background came into authority, they decided that this was a good technique. We should have Good Manufacturing Practices in the food industry. About a year and a half ago they published a proposed Good Manufacturing Practices for the food industry, which is very similar to those of the drug industry, clause by clause; however, with recognition of the differences in the industries. These were promulgated as proposed regulations. The question came up: Do they have the effect of law? Do they have the right to publish these as it is not in the Food and Drug Act? Their contention is that these are an extension of Section 402(a)4, which says that a product may be deemed contaminated if it has been prepared under conditions which might contaminate it. So they are setting forth in these Good Manufacturing Practices for food products an outline of the conditions that they think might possibly alleviate the contamination of the product.

Industry rose up in arms and many groups contested these. Some clauses therein are common-sense and some somewhat drastic or entirely new to the food industry. For example, you have to have a sanitarian appointed in charge of all of the sanitation features of the plant who has been properly educated either by experience or by college training. You have to keep records so that if you find something wrong in some batch of your product, you can go back and recall it for distribution in interstate commerce, and so forth.

The proposed regulations were in existence for many years and they were reissued last September in their revised form. I have five or six copies of these with me. If anybody is interested in a copy, I'll be glad to give them to you later. These contain two types of statements. They contain statements whereby a plant should do something or it shall do something. Their contention is that where regulations say "should," this is just an advisory statement. The policing should be done, but they really can't hold it against you. But where they say "shall," if you don't do it and aren't doing it, then you have violated this Section 402(a)4.

This involves many changes. People are going to have to do many things that they never did before. Therefore, the general trend now in the Food and Drug Administration is to try to be as educational as

possible, so they have evolved in the different industries, one by one what they call P.E.V's I don't know if they made these up for the dry milk industry, the dry yeast industry, and for certain other very key industries right now.

These P.E.V's are plant evaluation forms and they are strictly advisory, but are issued for your benefit to guide you in the things that you should be thinking about in your plants. If these come out for the cottonseed oil industry or for cottonseed meal plants, you should take them very seriously.

These all grew out of findings a couple of years ago that there had been a trememdous number of food poisonings and Salmonella contaminations. At that time principally, at least, Salmonella was in the dairy industry. Subsequently, they have found contamination in such diverse things as dry baker's yeast, coconut, red dye, and quite a number of others. Goodness knows where they're going to find it next, but it seems mostly to hinge around industries that use ingredients of animal origin.

There is a tremendous movement on foot today in the feed industry to be sure that all feeds sold to cattle are free of Salmonella. For example, there is a program going on now that all of you in the feed industry, I am sure, are familiar with. Most of the Salmonella problems that they are finding come from such things as blood meal or meat meal. I think you can appreciate that sources of that nature would necessarily be contaminated with Salmonella.

From listening to some of the talks today, it would seem to me that if you were thinking of selling cottonseed meal as a substitute for some of these animal meals, then you have a model sales proposition because it is certainly relatively easy to keep Salmonella out of cottonseed meal, rather than blood meal or meat meal. I think that armed with the proper facilities one could go out to the feed industry and sell many cottonseed meal for that purpose to people who have never used it.

Basically, we do a fair amount of our work as a consultant with the oil industry. We have found the mouse, rat, beetle, moth, and flies to be serious problems in meal houses, feed houses, hull houses, in mill areas, fan areas, sack hull houses, outside storage buildings, and in the seed house galleries. We even find that birds are a serious problem in the outside storage buildings and in the seed house galleries.

For the record, I would like to insert the following sanitation factors to be covered in the engineer's periodic inspection:

SANITATION FACTORS TO BE COVERED

IN

ENGINEERS' PERIODIC INSPECTION

1. **Seed houses** – Including meal, hull, hull sacking areas, outside buildings, fan houses, etc.

The following points should be checked to see if plant is conforming:

a. **Perimeter floor** and **floor-wall juncture** breaks where seed residues can collect to harbor beetles, weevils, and roaches.

b. Packed cotton in prominent **pillar crevices** harboring weevils and moths.

c. **Floor ducts** exhausted of accumulated seed and then residually treated.

d. **Seed belt box** along floor to see if it has been vacuumed.

e. **Breaks between floor box and foundation** where weevils, moths, and beetles develop.

f. **Thorough cleaning of overheads** from top down, to eliminate insect breeding material.

g. **Cleaning** and insecticidal treatment of **overhead horizontal box**.

h. **Inspection of pits, motors, motor-mounts**, on schedule, followed by cleaning and insecticidal treatment.

i. **Inspection of fan house** for roaches, weevils, stagnant water, and rodent nestings under and in equipment. Checking of bait boxes for fresh bait and evidence of rodent activity. Checking of rodent-proofing in the form of ill fitting doors and foundation breaks.

j. **Obsolete equipment** kept clean and stored away from walls, preferably in **out-building**. This includes bale bands, burlaps, etc.

k. **Ground foundation area** cleaning of seed spilled from probe ports and loose wall sidings. Treat with Larvacide after cleaning. Secure wall breaks. Remove all items stacked flush against seed houses or on ground next to them. Keep soil sterilized two or three feet away from house wall. Keep all weeds and grass cut. Sewer,

sumps, and culverts must be free from grass and treated against roaches, with residual insecticide.

l. **Removal** of piles of **accumulated cleaning chaff** on a daily basis.

m. **Possible entry into seed house** of large animals such as dogs, cats, possums, etc. This means snug fitting doors or screened entries, and checking for fecal evidence.

n. **Secure** window panes, eaves, doors of galleries against birds.

2. Meats and Hull Packing Areas

a. **Basement** and **ground areas must be checked specifically for**: 1) rodent burrows, especially those affording entry. 2) Caked residues that can support insect life. 3) Obsolete equipment, lumber, etc. 4) Miscellaneous debris such as lunch debris and bottles. 5) Enclosed bait boxes should be checked for signs of activity.

b. **Are loading ground areas free of residues**, trash, and weeds?

c. **Check floor-wall juncture** for breaks providing possible rodent entry, and entry of rain or permitting the spewing of residues onto the ground outside or under buildings.

d. **Check for rodent evidence** in overhead platforms, pit areas, dock canopies, unused equipment, etc.

e. **Are unused pits caked or clean**? Check for beetles, weevils, or roaches.

f. **Check track wells** along buildings for sour, decayed residues that might attract flies.

g. **Check miscellaneous equipment**, such as old pallets, pipes, straps, and motors flush against buildings, for residues that breed and attract rodents and insects.

h. **Are trash cans cleaned** and covered? Are flies present?

i. **Check for evidence of bird nesting** or entry in eaves, canopies, etc.

3. **Expeller Rooms**. Production Floor - Meats Bin, Seed Bins, Filter Bins, Filter Press, Rolls, Delinters, Etc.

a. **Check operational rooms, roof areas**, and along side adjacent ground areas for excessive chaff and spillage. What maintenance features could correct this? Has it been reported? Would a re-evaluation of departmental employee work procedures assist in preventing this?

b. **Check** the condition of **individual pieces of equipment**, for example, meats bin. Are the top ledges, interior ledges, horizontal augers, heads of drives, and conveyor free of caked meats. Where caked meats are encountered, check to see if they are putrid and maggoty.

c. **Check overhead ingredient ducts** or boxes to see if residues are transported in a guide chute instead of falling free and creating difficult to clean areas.

d. **Check** along **product floor, rotor lift, horizontal boxes, and seed box** for caked residues. Are employees assigned to "down time" periods for scheduled clean-up? Is this maintained adequately?

e. **Check wall-floor** and **wall breaks** for insect evidence.

f. **Check pits, pit walls**, and **floors** for breaks and crevices that might collect residues and harbor beetles.

g. Is plant provided with **self closing screen doors**, and are flies present?

h. Check the hangers in the canals from 9" to 6" box for "packing up" and spillage or product flow on the general floor area.

i. **Check rooms adjacent to expeller area for infestations of roaches**, for example obsolete oil room, toilet facility, etc. Check such rooms for wall breaks, old ducts, motors, pipes, and obsolete debris like bricks. Check for decaying packed residues on floor, at old press mounts, etc.

j. **Are obsolete pits cleaned** and kept free of stagnant water?

k. **Check switch panels** for cleaning and insect evidence.

l. **Check doorways** into the mill for good drainage. Are they pitched properly, or is there a seepage into the operation?

m. **Check handling of trash** from seed cleaners. It should be in covered cans or pushed off directly by air into a truck from an accumulation bin.

n. What is the condition of the trash barrels? Are they cleaned daily, and do they have covers?

Primarily in their inspection what the Government is interested in is – what is present in the areas where the oil is pressed and where the meal and the

cake are produced. They are interested in the sanitation involved in that process. Some of the sanitation in some plants is terrible and this I know for a fact. I am not bragging, but I don't think that it is as bad in those plants that we work with as it is in a great many others.

Just to give you an idea of what can happen – a couple of years ago the Government got an injunction against an oil plant that was producing cottonseed oil. Apparently, they took a position, as so many people have taken and are still taking, that cottonseed oil is made from an agricultural source and, therefore, it is subsequently purified. The Government didn't agree with them, so they got an injunction. I have here a blowup of a few paragraphs from that injunction in which the Judge is commenting. He says:

"It was alleged further that the insanitary conditions of the plant resulted from and consisted of the presence of bats and rats in the warehouse where cottonseed was stored. Bat excreta and poisonous insecticides intermingled with cottonseed (and this brings up another problem, as you have to be very careful with insecticides that you use and how you use them) in sub-stations of the manufacturing plants with flies and beetles. Roach excreta pellets on the covers partially covering the storage tanks. Roach pellets in the oil foam in the storage tanks.Cottonseed meal containing bat excreta. Bettle-infected cottonseed material above the screw conveyor where it carries a row of cottonseed meats into the press room.

"Skimmings off the oil in the troughs under the hydraulic presses which contains flies. Cottonseed oils in the settling tanks which contain several large insects. Cottonseed oil in the storage tanks which contains flies and roach pellets. Sweepings from the floor of the restroom being used in the manufacture of the article, and which sweepings contain flies. Nondescript dirt, gnawed bones, and food scraps discarded by the employees, which were swept off and placed in the processing stream.

"It was alleged further that the refining process of the expressed oil obtained from cottonseeds was such that the oil's soluble portions of the insect and the excreta pellets remained in the cottonseed oil. That the insanitary conditions also resulted from the system of general carelessness on the part of the defendant and his employees. And that the defendant had in storage in his plant cottonseeds which were held under insanitary conditions and the crude cottonseed oil consisted of filthy substances and which constituted a menace to inter-state commerce.

I think that is about as gross a situation as you can encounter. Gentlemen, that actually existed. I did not make that up. You can find it yourself if you want to look it up. It came out sometime ago, back in 1953.

The net result was that the Judge issued an injunction that the defendant will not hereafter produce unrefined cottonseed oil or operate his plant for this purpose in any manner, until it has completed the remodeling and renovation of his plant for the purpose of complying with good sanitation standards.

Now, again, I am not drumming up business, but I want to bring out the point that the Government is not operating a consulting service. They come in and find you at fault, they tell you what is wrong, and they expect you to correct it. It is your responsibility to do so. The plant is then set-up for further inspection by the United States Food and Drug Administration representatives. They made the above mentioned plant destroy part of the 200,000 pounds of unrefined cottonseed oil that they had on hand.

Now that is the sort of thing that you can run into. Should any of you who, up to the present, have never had any trouble with the Government subsequently have such trouble, you should immediately undertake to correct all of the conditions criticized in the Form 483. You should also undertake to go to the hearing which they will ask you to attend, present to them not just the fact that you cleaned up what they said was wrong, but that you have set up programs that will prevent these things from happening again.

This is the whole essence of industrial sanitation and it applies to every segment of the food industry. A plant must have a definite sanitation program. This involves proper inspection, proper insect control, and education of the employees in their knowledge of sanitation and responsibilities. I am sure that you have your responsibilities with your insurance companies that are in force. If you have Workmen's Compensation Insurance then you have to have a safety education program in your plant. If you

don't, your rates are unduly high. You can get them lowered by having such a program.

For this reason it is common in the food industry for people when hiring new employees to first teach them what they have to do in their job, and then teach them the safety factors of their job. Also, you have to teach them the sanitation factors of their job, or in other words, what can go wrong in the sanitation aspects of their job. That is part of such a program.

Then you have to have a definitely planned and organized scheduled program for these factors, and you have to have it in writing. Take all of this program that you outline in writing to the hearing to present to the Government to show that you really mean business. Then, I don't think that under the normal course of circumstances you will be prosecuted if this is a first violation. But, if you ignore Form 483, file it in File 13 (wastebasket), or if you put it in the Superintendent's desk and forget about it, then you are asking for trouble.

I have with me a few copies of the sanitation factors which need covering in seed houses and seed handling mills. If any of you are interested in this, I will be glad to give them out.

DISCUSSION

QUESTION: Dr. Holmes, you mentioned birds being a factor. Do you have anything to offer on the control of birds?

DR. HOLMES: Birds are the most difficult to control of any pest in an establishment. They are very hard to eliminate around an oil mill. The first step is to build them out. In other words, eliminate the avenues in which they can get in and contaminate the products with urea. This is often a lot easier to do than people visualize. Here in the South, where we often have open eaves, birds can flutter through the open eaves. You should close these. They can be closed by screening without hurting the ventilation any. But it has to be done even though there is some expense involved.

Then there are a good many tools, some of which are applicable to this industry and some of which are not. A few bird poisons are available. You have to use them on the outside as you cannot use them on the inside. We recommend that they be applied by an expert to actually kill the birds. You can eliminate flocks but, of course, you can't kill all of the birds in the neighborhood.

Another tool is a poison that is put on the outside and the birds are attracted to the area. They eat it and become nervous and act silly – somewhat like an LSD trip. The birds that don't eat it even get frightened away by those that do eat it and many of them never come back. This has had a lot of practical applications.

Actually, each case has to be studied for what it involves. First, build them out. Second, study whether the poisons will do any good. Then there are other things such as bird-repellants in the areas where they roost. Where you have a tendency for the birds to come back, for example, where they have roosted or where they have been born as fledglings, you can put up bird-repellants. This is a problem that has to be studied pretty thoroughly on the merits of the individual case.

Irv, do you have anything to add to that?

MR. KIESLING: Well, I would like to add that many times you get into the service organizations, (and you do) eliminate the situation, and then you forget about it. Later on you develop open windows, broken panes, and so on. This is where a lot of the people in the food industry get into trouble because they don't have a program that evaluates the maintenance of a construction such as seed houses and mill houses. This is the crux of the whole problem. You can eliminate it possibly for a short time, but in the long haul you have to have a self-inspection effort to achieve the maximum protection.

SESSION III: C. Y. Katzenmier, Jr., Port Gibson Oil Works,
Port Gibson, Miss., Chairman

AFLATOXIN – PRESENTATION, DETECTION, AND DEACTIVATION

by

L. A. Goldblatt
Southern Utilization Research and Development Division
New Orleans, La.

During the past few years considerable attention has been given to a number of toxic metabolites that are produced by certain strains of the common mold **Aspergillus flavus**. These toxic substances are not part of the living mold. They are chemicals produced by the mold. The molds can be killed without destroying the chemicals they have produced, but the molds must have been present at some time, and alive, to produce these toxins. To indicate their origin and their toxic nature they are called **A-FLA-TOXINS.** Eight of these aflatoxins have now been characterized chemically. Feeding studies have indicated that they have deleterious effects on laboratory and farm animals if the toxins are fed at sufficiently high levels and that some are potent carcinogens for some animal species. Also, the ingestion of aflatoxins by several lactating animal species has been reported to result in secretion of toxins in the milk (2). Fortunately the transfer is very low and the weight of toxins in the milk amounts to only about 1 percent of the weight of aflatoxins ingested. The presence of aflatoxins has been reported in a considerable number of agricultural commodities, including cottonseed and cottonseed meal, and that is the reason for my being here today.

For several years the Market Quality Research Division of the U.S. Department of Agriculture has conducted surveys to determine the extent of aflatoxin contamination in cottonseed and cottonseed meal produced in the United States. Each year roughly a thousand samples of cottonseed and a like number of samples of cottonseed meals produced by about 50 cottonseed processors, selected to represent all areas of production, were analyzed for aflatoxin. The results of these surveys for the years 1964 to 1967 have been reported by Whitten (21, 22). I shall not take the time to report all the details. In summary, a low incidence of aflatoxin was found in all 3 years, both in cottonseed and in cottonseed meal. In each year roughly nine out of ten samples of cottonseed and four out of five samples of cottonseed meal contained no detectable aflatoxin. About 4 percent of the samples of cottonseed and 10 percent of the cottonseed meal contained more than 30 p.p.b. of aflatoxin, a level that is considered biologically significant.

The apparently higher incidence of low or non-detectable levels of aflatoxin in cottonseed may be explained, in part, by the much greater difficulty of adequately sampling cottonseed. Thus, a single contaminated seed, if included in the sample taken for analysis, could easily contribute a very significant amount of aflatoxin to the sample, yet, if excluded (simply by chance owing to the relatively small size of the sample), could result in a sample with no detectable aflatoxin. But the aflatoxin in that contaminated seed, dispersed more homogeneously in the meal produced, may well result in a positive test in the sample of meal taken for analysis. Also, as relatively little aflatoxin is found in the linters, hull, or oil, aflatoxin that may be present will be found in proportionately larger amounts in the meal than in the seed. Thus, seed with only from 15 to 30 p.p.b. aflatoxin would be expected to produce meal with more than 30 p.p.b. For certain locations aflatoxins were present in each year; in some instances, aflatoxins were found at locations in one year but not in another year. So, we know that we may have a problem of aflatoxin in cottonseed and something of its dimensions.

I plan to discuss what we have learned about aflatoxin, especially as it relates to cottonseed, with respect to three major areas: (1) Suitable analytical methodology, (2) practical methods of preventing, or

at least minimizing, mold growth and production of aflatoxin, and (3) processes for removing or destroying aflatoxins in those lots that may have become contaminated. I shall concern myself primarily with cottonseed and cottonseed products, but I shall take the liberty of referring to relevant findings with respect to other commodities when that seems desirable.

First, with respect to analytical methodology, there is now available a method adopted last fall as Official First Action, by the Association of Official Analytical Chemists (AOAC) for the determination of aflatoxin in cottonseed and cottonseed meats and meals (16). That method was developed by Walter Pons whom many of you know, probably especially for his earlier work on the determination of gossypol. Walter is the Associate Referee for the AOAC for the determination of aflatoxin in cottonseed products. I shall not describe the analytical procedure but it is sensitive to less than 1 p.p.b. in cottonseed meats and perhaps to 2 to 3 p.p.b. in cottonseed meals, depending upon how severely the cottonseed has been treated in processing. An analysis takes about 4 hours to complete and a number of laboratories conduct analyses for a fee, usually about $15 to $20 per sample.

The analytical method developed by Walter Pons is a sensitive, accurate chemical method but it takes considerable time and requires a considerable amount of specialized equipment. The sampling problem is fantastic. That is the only word for it. A single seed may contain literally millions of parts per billion of aflatoxin. If there is just one seed like that in a million that has no aflatoxin at all, the whole lot will have several p.p.b. of aflatoxin. Finding a needle in a haystack is simple in comparison. A simpler, more rapid method for **detection** of contamination, even if it were somewhat less accurate or less reliable, would be highly desirable so that small lots of contaminated cottonseed could be readily recognized and set aside.

I would like now to digress for a short while and discuss with you experience in another industry which has been greatly concerned with the aflatoxin problem. The peanut industry has for some time paid a great deal of attention to detecting and diverting any aflatoxin-containing lots of peanuts as early as possible in the marketing process. Peanuts are normally graded at buying stations by qualified inspectors and the grade is based, in part, on the proportion of defective kernels in the Official Grade Sample. As early as 1964 substantially all the peanut shellers in the United States signed an agreement with the Commodity Credit Corporation of the U.S. Department of Agriculture that called for positive lot identification of all lots of shelled or in-shell peanuts, for analysis of all lots for aflatoxin content, and for diversion from food and feed channels of all lots of contaminated peanuts. In the 1968 Marketing Agreement a new important modification was made. In 1967 Dickens and Welty (6) of USDA's Market Quality Research Division report a high correlation between aflatoxin in farmers' stock peanuts (unshelled peanuts) and the presence in the defective kernels of the Official Grade Sample of mold that could be identified visually by use of a low-power microscope as A. **flavus**. That is, if examination under a low-power microscope of the relatively few defective kernels that the inspector normally sets aside to determine the grade shows mold visually recognizable as A. **flavus**, then there is a high probability that the lot from which the peanuts were drawn contain unacceptable levels of aflatoxin. The converse is also true. That is, if the defective kernels are free of visible A. **flavus** mold, there is a high probability that the parent lot is substantially free of aflatoxin. The test is not correct 100 percent of the time, but the odds are favorable. It was concluded that this is "a simple, effective method to detect peanuts that might contain large amounts of aflatoxin." Accordingly, the 1968 Marketing Agreement stipulates that every lot of farmers' stock peanuts will be examined at the buying station by an inspector trained to perform the inspection for mold and that any lot that contains visible A. **flavus** will automatically be restricted to nonedible uses (1). It is hoped, and anticipated, that this will result in a major reduction in the proportion of shelled peanuts containing traces of aflatoxin by preventing the mixing of small lots of contaminated peanuts with large lots free of aflatoxin.

We do not yet have a comparable simple method for cottonseed that is as well established as is the one for peanuts. But such a method is being sought and one promising approach is being studied by several laboratories.

In 1955 (before the discovery of aflatoxin),

Marsh and coworkers (13) reported that a previously undescribed boll rot of cotton that is characterized by a bright greenish yellow (BGY) flourescence in the fibers is caused by infection by the fungus **Aspergillus flavus**. This fluorescence is seen only infrequently and is sometimes called "cat eye." Examination under ultraviolet light for the distinctive BGY fluorescence was used for rapid recognition of this kind of damaged lint (associated with "yellow spot disease") that caused difficulties for the spinner and dyer of such damaged cotton fiber. With the discovery of the aflatoxins and the association with the same mold, **Aspergillus flavus**, attempts were made to utilize this fluorescence as a marker to identify seed that contains aflatoxin. Data from three different laboratories have now been reported suggesting a relation between this fluorescence that might be observed in the fiber, or associated with the seed, and aflatoxin in the cottonseed (3, 4, 14, 21, 22).

Marsh and others (14) concluded that when the typical BGY fluorescence is seen in field-collected cotton fiber, one can be quite certain that A. **flavus** infected the fiber and that it did so at the time of boll opening and further that there seems to be a trend for the fluorescence in the fiber of an individual boll to be accompanied by high aflatoxin levels in the seeds of the same boll but there are exceptions.

Ashworth and McMeans (3) concluded that a close relationship exists between fiber fluorescence and seed infection. They also found a high correlation between fluorescence in fuzzy cottonseed from these samples and contamination with aflatoxin. Although they found some aflatoxin in some samples of nonfluorescent seed the aflatoxin concentration generally averaged very much higher, commonly by a factor of 1,000 or more, in the fluorescent samples than in the nonfluorescent samples. They also found that the bottommost fruit on plants is more seriously affected by A. **flavus** than fruit from other parts of the plant. That is, the seed collected from the bolls picked from the lower third of the plant, near the soil surface, had much higher levels of aflatoxins.

Whitten (22) reported that when gin-run cottonseed were examined with ultraviolet a difference was observed in fluorescence from cottonseed with and without aflatoxin. In general, when aflatoxin was found in the seed, fluorescence could be observed in the foreign material associated with the seed, especially the ends of the stems and other broken bits of the plants. Often a few cottonseed fluoresced; but when there was no aflatoxin in the cottonseed, this fluorescence could generally be observed either in the foreign material or in the seeds. The flourescence varied from blue to green-yellow and the degree of fluorescence was observed to increase as the aflatoxin content of the seed increased. Whitten concluded that the test appears to be a practical screening technique for separating lots of "suspect" seed from lots that are not contaminated and so prevent contamination of large quantities in storage houses.

So much for Detection. How about Control? The first, and undoubtedly the best, approach is Prevention. The first step is recognition and awareness that the problem and the threat exist. A major problem is motivation of untrained personnel at all stages of culture, harvest, transportation, and processing. The Agricultural Research Service of the U.S. Department of Agriculture recently issued a report entitled "Preventing Mycotoxins in Farm Commodities" (20). This report emphasizes that the simplest and most practical way to prevent aflatoxin contamination is to prevent mold growth and it includes suggestions of recommended farming practices for controlling mold growth in cottonseed as well as other agricultural commodities. The following is quoted (20, p. 5) from the section on cottonseed:

"Good farm management practices and proper handling in processing and marketing channels are the best safeguard against molding in cottonseed.

"In the few isolated areas where **Aspergillus flavus** has been found in growing cotton, it is usually associated with hot, humid conditions and excessive plant growth. The humidity may be caused by the weather or by excessive irrigation.

"To minimize the mold problem during the growing period, farmers should use just enough fertilizer and irrigation water for optimum growth. Overfertilization and overirrigation promote rank growth and boll rot on the lower part of the plant. Bottom defoliation when these lower bolls are mature is known to prevent boll rot, which is caused by some molds.

"To avoid exposure to rain or high humidity in the field, cotton should be harvested as soon after opening as economically feasible. To prevent mold

developing after the cotton is harvested, farmers should try to avoid harvesting the cotton when it is damp. In many cotton-producing areas, the Weather Bureau supplies daily information on the time when the morning dew will have dried sufficiently for safe picking.

"Mechanical cottonpickers should be operated carefully to prevent seed cracking, which might provide the opportunity for molds to invade the kernel.

"Farmers and ginners should not leave the harvested cotton standing in trailers for long periods, where the cotton is exposed to wetting and heating. If the seed cotton moisture is high or if the trailer load contains large amounts of green leaves or other trash, even 24 hours is long enough for the cotton to deteriorate and mold to begin to grow.

"In storage of cottonseed, reducing the moisture and temperature to safe levels is important for mold prevention. Cottonseed with about 10-percent moisture content and adequately aerated has been stored without known significant damage. Maintaining clean storage facilities and keeping damaged seed separated from sound seed should help reduce the danger of contamination."

As the report (20) states, high moisture is the single most important condition contributing to mold. Temperature is also very important but moisture control is crucial in mold prevention. Prompt drying and testing for moisture content are essential. The safe moisture level varies not only with the crop but also with the length of time it is to be left in storage, the temperature of storage, weather conditions in the area, the design of the storage facilities, and still other factors. Recommended safe moisture levels refer to **all** the seeds in the lot that is being stored **not** the **average** moisture content. For this, proper aeration is required. Without adequate aeration significant differences in temperatures between different locations in stored material may build up, causing the moisture to concentrate to damaging levels in the colder spots. Such uneven moisture distribution may result in serious mold growth even when the average moisture content would appear to be at a safe level. Mold growth causes the formation of water. Once fungal growth has started in one excessively wet seed the moisture content of the immediately adjacent seed also increases and further fungal proliferation may proceed regardless of the average moisture content, resulting in a pocket of highly contaminated material. Accordingly, adequate sampling and testing are necessary.

Although recommended measures for preventing molds in storage are generally well known sometimes they are overlooked or slighted for various reasons, such as work pressure or lack of suitable facilities. I recommend that you refer to this publication (20) for reminders for obvious needs ranging from weather-tight bins to good insect control practices. Obviously contaminated lots of cottonseed should, whenever possible, be screened out and not blended with good lots. For this, the fluorescence tests discussed earlier should be helpful. Lots found to be contaminated possibly can be blocked out at the gin and set aside in a manner similar to that currently used in the peanut industry. I have already noted that the bolls from the lowest part of the cotton plant are especially susceptible to boll rot and to contamination with aflatoxin. Bolls produced under similar humid, shaded conditions should also be suspect.

But damage and contamination with aflatoxin may occur despite the most strenuous efforts directed at prevention. Then other approaches must be considered, fully recognizing that they are to be applied only if preventive measures have failed and not as an alternative to good practice. I shall discuss two approaches: (1) removal, and that includes removal by mechanical means and by use of solvents and (2) destruction.

Our experience and that of others who have reported showed that the vast majority of the aflatoxin in contaminated cottonseed and peanuts reside in a relatively small number of seed. This affords an exceptional opportunity for effectively yet economically reducing the aflatoxin content by mechanical removal of those few seed or kernels that may have become contaminated. Physical separation methods are being used successfully in the peanut industry. In fact, use of a "sorting Procedure" is prescribed in the Voluntary Code of Good Practices (1) adopted by the peanut industry. Several types of electric sorting machines are available but the basic principle of operation is the same. In all cases individual kernels are inspected by an "electric eye" and those that are off-color compared with some

preset standards are separated from those of acceptable color.

In the case of cottonseed we cannot distinguish contaminated from uncontaminated cottonseed in ordinary light but several laboratories have reported a high correlation between a BGY fluorescence in fuzzy seed and aflatoxin content. Ashworth and others (4) have proposed using this property to separate contaminated cottonseed. They reported on results obtained with a machine used in the almond industry to separate nicked almonds from sound seeds. Fluorescent oil shows up in the fissures in the seedcoat of nicked almonds and that actuates a rejection device. When applied to cottonseed, individual seeds are held by vacuum to fingerlike holding ferrules on a revolving presentation wheel. Each seed passes separately through the ultraviolet lamp house. If it fluoresces, the seed is deflected into the reject product compartment by an air jet that is activated by the emitted fluorescent light; if it does not fluoresce, the seed is released to fall into the accepted product compartment by automatic release, at the appropriate point, of the vacuum that holds the seed to the ferrule. The data of Ashworth and others (4) showed that by using this equipment it is feasible to sort out from seed lots fluorescent gin-run seeds but not mechanically delinted seed. The fluorescent seeds accounted for only a small proportion of the total seeds in any seed lot tested, about 0.3 percent on the average, but the machine was never less than 91 percent effective in removing the fluorescent seed in gin-run fuzzy seed. Although electric-eye sorting probably does not offer a practical solution to the problem the cottonseed processor faces in removing aflatoxin contaminated seeds, such a device might be used to identify contaminated lots of cottonseed and permit prompt segregation. A similar machine that uses ordinary visible light rather than ultraviolet is currently used in the peanut industry to separate peanuts on the basis of color differences.

Holzenthal and others (10) showed that cottonseed can be separated into fractions of different quality, that is, free fatty acid content, light immature and decayed seed, foreign matter, and others, by use of projection devices. The highest quality seed are projected farthest because of their ballistic characteristics. In our first test to separate aflatoxin-contaminated cottonseed by projection very encouraging results were obtained (7). In this test we used a lot of delinted cottonseed that contained 40 to 80 p.p.b. of aflatoxin. More than 63 percent of the aflatoxin was concentrated in about 6 percent of the seed, and about 85 percent was concentrated in 25 percent of the seed. Although the separation was not so good as might be desired, it did indicate potential for separation of aflatoxin-contaminated cottonseed by this procedure. Unfortunately, in another test with another lot of seed that contained about 750 p.p.b. of aflatoxin, little or no segregation was achieved. A suggested explanation for the difference in results is that two different types of aflatoxin contamination were involved. In the first lot the contamination probably occurred before harvest. In the second lot the seed had been subjected to biological heating in the storage pile and thus the mold, and the resulting aflatoxin, had spread throughout the whole mass of seed (7).

A zigzag separator has been used successfully to separate nonviable cottonseed from viable seed on the basis of density. In this separation, a current of air is forced up through vertical zigzag chambers into which is fed the material to be separated. This equipment has shown some promise in separating aflatoxin-contaminated from uncontaminated peanuts. However, when this was tested with cottonseed, little or no separation was achieved. The cottonseed used in this test was from the same lot that gave poor results on projection (7), and this approach should be explored further with other seed.

Let us now consider removal of aflatoxin by extraction. The feasibility of removing aflatoxin by a simple washing or "laundering" operation, for example washing whole peanut kernels with water or dilute alkali, has been the object of much discussion. The aflatoxin contents of different parts of peanut kernels containing large amounts of aflatoxin have been determined (5) and high concentrations of aflatoxin were found deeply embedded in individual peanut kernels. Accordingly, even if simple laundering of whole or split peanuts removed superficial aflatoxin, effective removal would not be realized.

On the other hand, good potential for removing aflatoxin is offered by extraction with polar solvents during the processing of various oilseeds, such as cottonseed and peanuts, to oil and meal. Current processing practices, either mechanical expression or

extraction with commercial hexane, leave in the defatted meal the vast majority of any aflatoxin that may be present in the seed. However, polar solvents, such as alcohols or acetone, readily extract aflatoxin and several possibilities exist to remove aflatoxin from oilseed products. These include (1) extraction of aflatoxin from defatted meals, (2) simultaneous extraction of oil and aflatoxin from flaked meats or prepress cake, and (3) selective extraction of amounts of oil or meal components leaving a full fat product, free of aflatoxin, available for conventional oil extraction.

Perhaps it would be well at this time to note that removal of aflatoxin from oils present no problem. Crude oils may contain various amounts of aflatoxin depending upon the raw material used and the conditions used in processing. However, Parker and Melnick (15) established quite conclusively that conventional processing of cottonseed and corn oil, deliberately prepared to contain high levels of aflatoxin (more than 100 p.p.b. of B_1), removes essentially all the aflatoxin. Refining with aqueous sodium hydroxide removed the greatest part of the aflatoxin, and after bleaching with AOCS Official Bleaching Earth, the oils contained less than 1 p.p.b. of aflatoxin.

A solvent system of acetone-hexane-and-water, originally developed and investigated on a pilot-plant scale to remove gossypol along with oil from prepared cottonseed meats, (2) also was found to remove aflatoxin quantitatively from ground peanuts or peanut meal while removing relatively little extraneous material other than oil (9). Gardner and others (9) recently reported on the effectiveness of a tertiary solvent system of 54-percent acetone, 44-percent hexane, and 2-percent water (by weight) for reducing the aflatoxin content of contaminated prepressed peanut cake to a level of 30 p.p.b. or below. They also reported similar effectiveness of a binary system of 90-percent acetone and 10-percent water (by weight) for reducing the aflatoxin content of contaminated peanut and cottonseed meals.

Pons and Eaves (17) suggested a technique for extracting gossypol and aflatoxin from flaked cottonseed meats using 70-percent acetone (by volume) followed by conventional oil-extraction procedures. They reported that the meals they obtained are light-colored, exceptionally low in gossypol pigments, high in protein and available lysine content, and that the crude oils are light-colored, contain negligible amounts of gossypol, are high in neutral oil content, and refine and bleach to a prime color value. They concluded "the process is effective for the removal of such toxic mold metabolites as aflatoxins from mold damaged seed."

Removal of aflatoxin from oilseed meals by aqueous alcohols has been studied and Rayner and Dollear (18) have reported that extraction with 80-percent aqueous isopropanol at 60° C resulted in complete removal of aflatoxin from cottonseed and peanut meals in six passes. Obviously a variety of polar solvents are effective for the removal of aflatoxins.

Although the prospects for removal of aflatoxin from intact seed, such as peanut kernels, by means of solvents is not good, several solvent systems may be quite suitable for use in the preparation of oils and meals or flours, especially solvent systems based on acetone or on alcohols such as isopropanol or ethanol. Such solvent systems have the advantage that under suitable conditions they can remove essentially all the aflatoxins with little likelihood of forming from the aflatoxin products having adverse physiological activity and without appreciable reduction of protein content or its nutritional quality. On the other hand, there is the cost of additional processing, the need for special extraction and solvent recovery equipment, and perhaps the loss of some water soluble components of the residual meals.

Destruction

Finally, there is the possibility of degrading, destroying, or otherwise inactivating the aflatoxins – for example, by heat or chemical or biological methods. Any such treatment must, of course, not only inactivate the aflatoxins but also leave unimpaired the nutritive value of the material processed and leave no deleterious residues.

Unfortunately, aflatoxin is very stable to heat. Mann and others (12) made a detailed study of the effect of heat and moisture on aflatoxins in oilseed meals. Treatments at 60° and 80° resulted in very little reduction of aflatoxin but treatments at 100° C. resulted in definite reduction. The effect was enhanced by increasing times of heating and of moisture

contents. About 80 percent reduction in aflatoxin was achieved by heating oilseed meals for 2 hours at 100° at 20-percent moisture. They concluded that although increased moisture content results in increased destruction of aflatoxin, application of heat and moisture alone is not a very satisfactory method to inactivate or remove aflatoxin from oilseed meals.

A host of chemicals have been screened as reagents for the destruction of aflatoxin. Dollear and Gardner (7) reported results of an extensive study. More detailed studies were conducted with the most promising reagents and Dollear and Gardner (7) reported some of the results. The most promising chemical reagents were judged to be ammonia, methyl amine, and sodium hydroxide. Most of this work was with peanut meal, but I shall mention here only the results that were obtained in one run with cottonseed meal (7). This cottonseed meal originally contained 187 p.p.b. total aflatoxins and had 6.6 percent moisture. It was treated with anhydrous ammonia gas at a pressure of 40 p.s.i.g. for 1 hour at a temperature of 178° F. (81° C.) in a 25-gallon black iron steamjacketed pressure reaction vessel. This treatment appeared to be 100 percent effective in destroying the aflatoxin as none could be detected in the treated meal. The initial nitrogen content of the meal was 6.56 percent, corresponding to 41.1-percent protein. After ammoniation the meal contained 7.13-percent nitrogen indicating addition of 0.57 percent nitrogen from the ammonia. Chemical indices indicated that the nutritive quality of the ammoniated cottonseed meal had not been appreciably degraded by the treatment. Thus, the initial nitrogen solubility of 71 to 80 percent was reduced to a final value of 58.06 percent and the available lysine content was reduced from 2.74 to 2.57 grams per 16 grams of nitrogen. It is planned to conduct tests of ammoniation of contaminated cottonseed meal on a larger scale to determine economic feasibility and to evaluate the nutritional quality of the treated meal in feeding tests.

SUMMARY

A low incidence of aflatoxin has been found in surveys conducted during the past three seasons of samples of domestic production of cottonseed and cottonseed meals. Sensitive and accurate, though time consuming, methods have been developed for determining aflatoxin in cottonseed products. A bright greenish-yellow fluorescence observable when contaminated fiber or seed is exposed to ultraviolet light appears to have potential value for identifying lots of aflatoxin-contaminated cottonseed. Prevention of contamination is the best approach, and appropriate preventive measures should be taken at all stages of culture, harvest, transportation, storage, and processing. If prevention has failed, contaminated material may still be salvaged – but, at a cost – by mechanical removal of contaminated seed, by extraction with polar solvents, or by destruction of aflatoxins with appropriate chemicals. Aflatoxins that may be present in crude oil are effectively removed in the conventional refining operations.

ACKNOWLEDGMENT

The contributions and cooperation of L. P. Codifer, Jr., A. F. Cucullu, C. T. Dwarakanath, F. G. Dollear, P. H. Eaves, A. O. Franz, H. K. Gardner, Jr., G. R. Hennessey, S. P. Koltun, L. S. Lee, G. E. Mann, R. Y. Mayne, W. A. Pons, Jr., E. T. Rayner, J. A. Robertson, D. B. Skau, D. J. Teunisson, and H. L. E. Vix are gratefully acknowledged.

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DISCUSSION

QUESTION: Do you have any suggestion under Prevention from keeping a farmer from picking half a trailer of cotton, leaving it in the rain for 2 days and waiting 2 more days, and finally going back and finishing it before he brings it to the gin?

DR. GOLDBLATT: No, I don't. But that is one of the reasons I read some of these sections from that report, "Preventing mycotoxins in farm commodities." Much of that, of course, is directed to the farmer and I gather the ginner has relatively little **control** over what the farmer does. It is also a matter of communication and education. All that we can do is do the best we can to inform the farmers. Something I was trying to make a point on earlier is that it is necessary to get people to be **aware** of the problem. That is a major problem in itself; just getting them to be **aware** of it. After they are aware of it, then next try to get them to take the proper steps.

AERATION SYSTEMS AND THE STORAGE OF COTTONSEED IN COMMERCIAL FACILITIES

by

L. L. Smith
Delta Branch Experiment Station
Agricultural Research Service, USDA
Stoneville, Miss.

Cottonseed has been aerated in one way or another for many years in an attempt to cool and maintain its quality. Many factors can contribute to quality loss in cottonseed. Increases in free fatty acid, loss in germination, and other deterioration during the storage period are of much concern. Two important factors, with which we are all familiar, are the moisture content and temperature of stored cottonseed; if either one is too high, quality loses can result. Generally, the warehousemen try to store cottonseed at a moisture content of 12 percent or below. This is not always possible. If it is higher than 12 percent, the storage problem is aggravated and aeration becomes more important. However, rapid or progressive cooling of the cottonseed to between 50° and 70° can be expected to maintain the cottonseed quality. To date, reliable research information is not available to confirm these moisture and temperature limits, or to determine other satisfactory combinations.

Reliable information on the resistance of cottonseed to airflow is necessary in designing an aeration system. Only limited technical engineering data are available on the satisfactory aeration of stored cottonseed. Tests conducted by Allen Brashears, Agricultural Engineer, Agricultural Research Service, provide information on resistance of linted and delinted cottonseed to airflow. Field study work by W. B. Harris, Research Engineer, Texas Engineering Experiment Station, provides further information on this subject. The work by Harris has not been published, but I will comment more on it later.

Despite the fact that cottonseed has been aerated for many years, very few warehousemen know how much air they are moving through cottonseed. Additionally, various fan operation programs are being used: some warehousemen schedule their fan operation, while others start the fans and let them run continuously.

My first work during the 1962-63 storage season was devoted to studying prevalently used aeration systems in commercial cottonseed storages with capacities of 450 to 2,000 tons. These systems included the so-called flat storage and the Muskogee-type storage. In many of the storages, the common pallet-type aeration duct and small-diameter air pipes in the floor were used for air distribution. Wide differences were observed in the amount of air moved through the cottonseed. The use of large fans and motors did not necessarily mean that large amounts of air were being moved through the cottonseed. Electric motor sizes of 10 to 200 horsepower are being used in presently installed aeration systems. Many of the systems probably use from 25 to 75 percent of the power in moving the air through the systems. Researchers feel that only 10 percent of the power output should be needed for this purpose, leaving 90 percent, the majority of the power output, to move air through the cottonseed.

High friction in the aeration system reduces the quantity of air moved through the cottonseed. Much of this friction is created in two places in the system: (1) where the air moves at high velocity through the cottonseed near the aeration duct surfaces, and (2) where the air moves at high velocity through small diameter supply pipes that connect the aeration ducts to the fan. Air-pressure loss in the seed surrounding the aeration ducts is affected by the number and size of open areas, in the duct surfaces, through which air passes from the cottonseed into the ducts. For example, the wood pallets commonly used have only small open areas beneath the pallet. Figure 1 illustrates how the air must converge to enter the wood pallets. As it converges at these points, the velocity of the air increases in the seed near the openings; this, in turn, increases the static pressure. Thus, more power is needed to move the necessary air through the cottonseed.

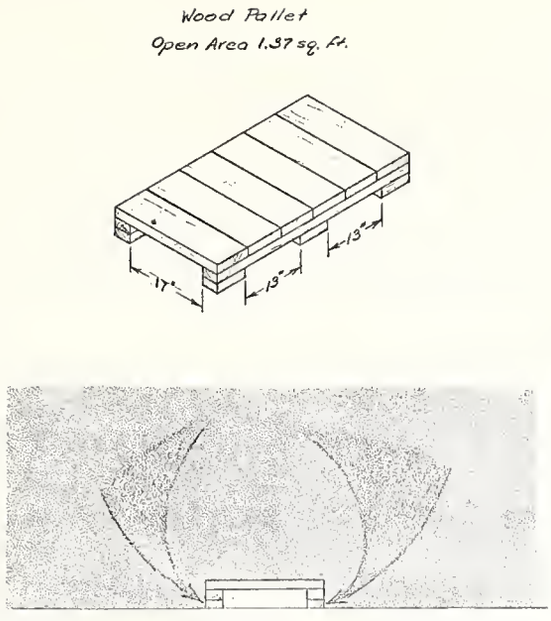

Figure 1. **Pallets with narrow openings increase the resistance to airflow; therefore, more power is needed to aerate the cottonseed.**

A laboratory study was made recently with a simulated depth of 20 feet of cottonseed. Results of the study indicated that when the velocity of the air through the cottonseed near the duct surface is increased from 10 to 20 feet per minute, the static pressure is nearly doubled. When the air velocity is increased to 50 feet per minute, the static pressure is more than seven times as great as that at 10 feet per minute.

Aeration ducts can be designed with sufficient perimeter and length to provide the necessary surface area once the amount of air each duct is required to carry is known. With a properly designed duct having sufficient surface area, velocities in the seed surrounding the duct can be held within the generally recommended limit of 10 to 20 feet per minute. Adequate duct surface area can be obtained by using A-frame, round, half-round, or other similar designs with openings uniformly spaced over the entire surface area. Figure 2 shows an A-frame type of duct with openings where air can enter over the entire surface, instead of through small, restricted openings as with the pallet, figure 1.

Some improvements in aerated storages have resulted from our suggestions. In one storage with an improved system, a 40-horsepower motor was replaced by a 10-horsepower motor. The smaller motor and fan aerated 50 percent more cottonseed than the original system and delivered over 50 percent more

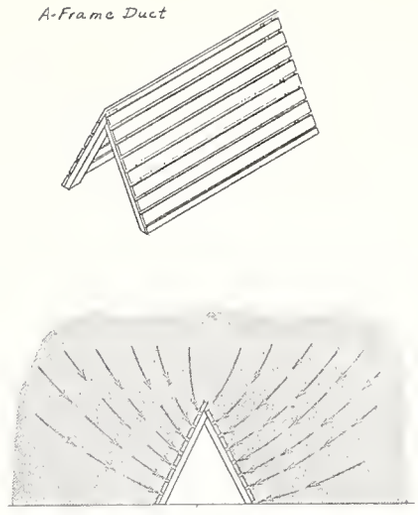

Figure 2. **The use of "A-frame" ducts with a large surface area and many openings results in a minimum resistance to airflow.**

air, 3,380 cubic feet per minute. Properly designed systems can minimize power requirements and fan running time.

At another storage facility, a 75-horsepower motor and fan moved only 5,500 cubic feet of air per minute through 14,500 cubic feet of cottonseed. The velocity of the air through the cottonseed near or around the pallets was calculated to be several times more than the 10 to 20 feet per minute recommended. The velocity of the air in the 6-inch supply pipe was calculated to be 5,500 feet per minute, whereas the recommended velocity is 1,500 feet per minute. Recommendations allow for velocities as high as 2,500 feet per minute in relatively short pipe lengths.

An improved aeration system was designed and installed in a portion of one storage accommodating 35,000 to 40,000 cubic feet of cottonseed. Aeration ducts were designed to provide an air velocity of 10 feet per minute or less through the cottonseed near the duct surfaces. The unloading tunnel in that part of the storage was sealed off at both ends, making it the main supply pipe leading to the fan. An industrial exhauster-type fan and 7-1/2-horsepower motor were used to aerate the cottonseed. The fan was operated by automatic controls consisting of a thermostat and a humidistat wired in series in the control circuit. These controls started and stopped the fan at predetermined settings of temperature and relative humidity.

Cottonseed started moving into this storage the first week in October 1964. It had an average temperature of 81°, with some temperatures as high as 90° F. By the first of February 1965, 550 hours of fan operation had occurred, and the average cottonseed temperature was 48°. Two months later the average cottonseed temperature was just slightly above 50°.

In still another storage, 52 feet wide x 200 feet long, generally filled with cottonseed to a depth of 22 to 25 feet, the unloading tunnel was revamped and used as the only aeration duct. Part of the tunnel wall, the length of the tunnel, was removed and replaced with hardware cloth. The tunnel was sealed at both ends of the building, and bulkhead doors were installed in the tunnel at 50-foot intervals. Supply pipes were installed in the tunnel to provide aeration for each 50-foot section. Two low static pressure (6 inches maximum) fans were used, one at each end of the tunnel. The system devised was found capable of aerating the entire storage (2,400 tons) at one time.

This type of system offers several advantages over the original system: (1) it is possible to have a clean floor; (2) the airflow distribution is greatly improved; (3) pallets are not necessary, therefore the time and labor involved in putting them down, taking them up, and maintaining them are eliminated; (4) the horsepower requirement for the motor providing fan operation for aeration is greatly reduced (this system uses two motors of only 7-1/2 horsepower – one to power each of the two fans – as compared with the 75-horsepower motor required for the original system); and (5) this system can aerate an entire storage at one time, whereas the original system could not.

Figure 3 gives a cross-section of and shows the aeration system used in a typical cottonseed storage. The storage has wood pallets on the floor and small diameter pipes laid in the floor. The top sketch shows cottonseed temperatures in October before any fan operation or cooling had taken place. The lower sketch shows seed temperatures for the following February after aeration was stopped. The temperature lines indicate that proper cooling had taken place near the outer walls in the lesser depths of cottonseed, where the large pallets were located. Temperatures as high as 74° F in the deepest cottonseed along

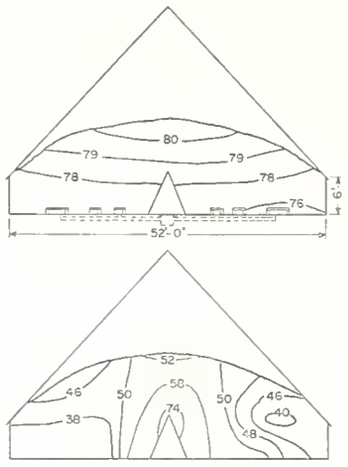

Figure 3. Typical cottonseed aeration system with floor pallets and supply pipes in floor. (Above) Initial cottonseed temperatures when seed stored in October. (Below) Cottonseed temperatures in February after aeration was stopped; shaded area 50° F. and above.

the main tunnel illustrate unequal air distribution and inadequate cooling resulting from the poor system design. Studies have proved that considerable air leakage occurs from the tunnel into the pallet closest to the tunnel. In one storage where the entire tunnel has been covered with sheet plastic, the efficiency of the aeration system has been greatly improved over that of the original system.

Figure 4 gives a cross-section of a typical storage where the pallets have been replaced by larger A-frame aeration ducts. The main tunnel is used in this system as the supply pipe leading to the fan. The

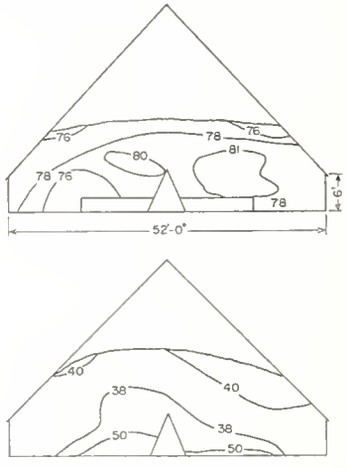

Figure 4. Improved cottonseed aeration system with A-frame ducts and air exhausting into the main tunnel. (Above) Initial cottonseed temperatures when seed stored in November. (Below) Cottonseed temperature in February after 550 hours of fan operation; shaded area 50° F. and above.

top sketch shows the temperatures of the cottonseed in November. The lower sketch shows the temperatures of the cottonseed in February, after 550 hours of fan operation. The relatively uniform temperatures shown in the lower sketch indicate a much more uniform airflow distribution and cooling pattern through the cottonseed mass than those shown after aeration in figure 3. This emphasizes that proper system design is necessary for uniform airflow distribution and cooling.

Every aeration system installation has its own individual design problems. Before designing a system and selecting aeration equipment, the following factors should be considered: (1) The size and type of structure in which the system is to be installed, (2) the depth of the cottonseed through which the air will be moved, (3) the airflow rate per cubic foot to be provided, and (4) the quantity of cottonseed to be served by each fan. After these points have been considered, determinations should be made for: (1) Total air volume to be supplied, (2) the static pressure against which the fan must operate, (3) the size and type of fan and motor needed, and (4) the kinds of aeration ducts and supply pipes needed.

The design and selection of aeration equipment should also include consideration of the method to be used for control of the fan operation. The advantage of maximum use of the cooler air that is available in the early morning and late evening can be gained through the use of automatic controls – a thermostat and humidistat, or through the use of a time clock, which can be set to start and stop the fan at times predetermined to be the most effective. This advantage may not always be possible with manual controls, because there are many times when the warehouse manager may not be available to start and stop the fans.

One of the factors needed for determining proper design of an aeration system is the resistance to airflow of the total mass of cottonseed. As noted above, Allen Brashears determined this resistance for a unit depth of cottonseed. In 1960, W. B. Harris initiated a study to determine how the calculations for this resistance should be modified to include the effect of compaction in a mass of cottonseed. In the course of his work, he developed an instrument to measure the density of the cottonseed and its effect on airflow. Basically, the instrument uses a specially designed hollow metal tip that is inserted into the stored cottonseed. A double-walled pipe serves to probe the tip into the cottonseed. In operation, a measured amount of air is forced through the outer pipe out the tip. The inner pipe serves as a static pressure line to a manometer which indicates the static pressure of the forced air at the probe tip. The dissipation rate of this air into the cottonseed was determined. Harris then calculated a density factor based on this rate.

Late in 1965 the studies by Harris were expanded under a research agreement between the U. S. Department of Agriculture and the Texas Engineering Experiment Station. New probe tips were designed, built, and calibrated and then brought to Mississippi for testing under actual bulk cottonseed storage conditions.

The warehouse in Mississippi where the field tests were conducted is a large Muskogee-type storage, 150 x 160 feet, with cottonseed depths up to 80 feet, and with a capacity of 14,000 tons. All of the aeration system is installed above the floor. Most Muskogee-type storages use some kind of lateral aeration ducts or pallets, but this storage uses the unloading tunnel as the main aeration duct. Wood pallets, constructed of 2- x 6-inch vertical members and 2- x 4-inch cross members, are positioned against the tunnel to provide additional open area for air to move from the cottonseed into the tunnel. Two 36-inch diameter concrete tiles are used as supply pipes connecting the tunnel with the two fans outside the building.

Density factors have been determined for cottonseed in various shapes and sizes of storages. Use of these density factors provides a much better opportunity to correctly design an aeration system that distributes air uniformly.

Indications are that the density of cottonseed does not increase appreciably in depths of cottonseed greater than 45- to 50-feet. Of course, static pressures continue to increase with increased cottonseed depths. During one observation at this same storage, static pressures of 10.0 to 10.5 inches water gage were measured at depths of 65 feet. Static pressures within the tunnel were measured at 19.7 inches and, at the two fans, at 21.7 and 22.5 inches. About 1 foot from the tunnel, the static pressure was 15.8 inches. The velocity of the air at this point was

calculated to be 20 feet per minute – within the range of present recommendations.

Temperature data were also taken in this storage during the same study. The data provided some interesting information regarding temperature and airflow patterns. The data gathered on temperatures are especially interesting in view of the design of the storage where this study took place, where, as previously mentioned, no lateral ducts or pallets were used in the aeration operation – only the main tunnel with the pallets positioned along its sides.

The temperature data were obtained from thermocouple cables spaced throughout the cottonseed mass. Figure 5 gives isotherms representing temperature data taken on October 22, 1966, at which time the storage was not completely filled but the floor was covered. The fans had operated a total

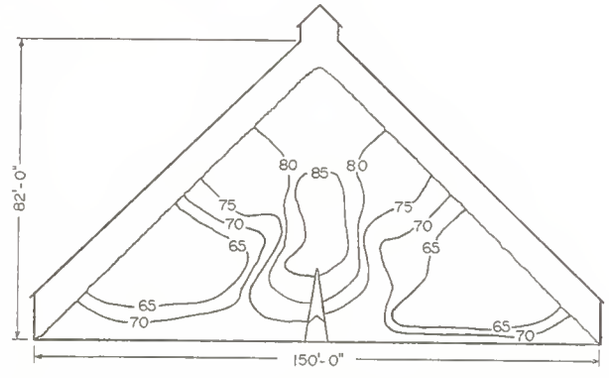

Figure 5. Cottonseed temperatures in large storage after 590 hours of fan operation.

of 590 hours, and there were already indications that more cooling had taken place on the sides of the pile than elsewhere. Figure 6 shows isotherms of the data taken on December 22, 1966, after 2,040 hours of fan operation, and shows further cooling. Figure 7 represents the data taken January 20, 1967, after

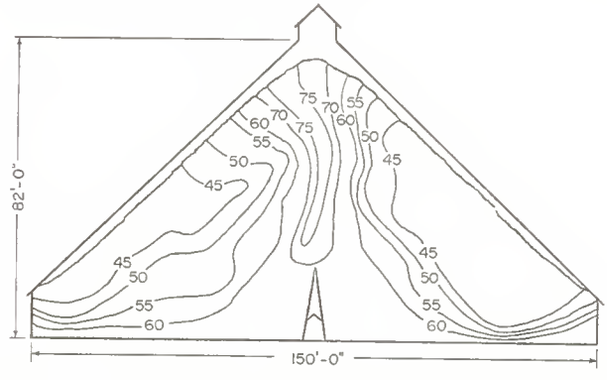

Figure 6. Cottonseed temperatures in large storage after 2,040 hours of fan operation.

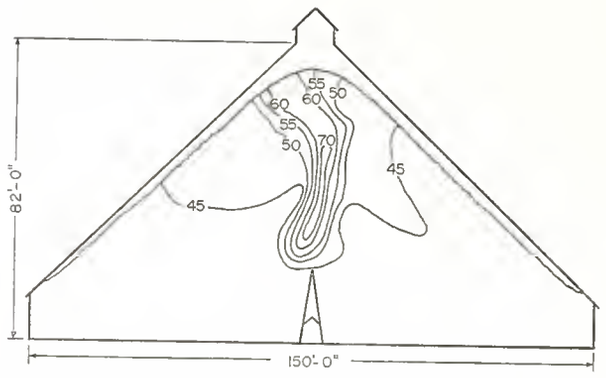

Figure 7. Cottonseed temperatures in large storage after 2,498 hours of fan operation.

2,498 hours of fan operation. The temperature lines in this figure indicate that most of the cottonseed had

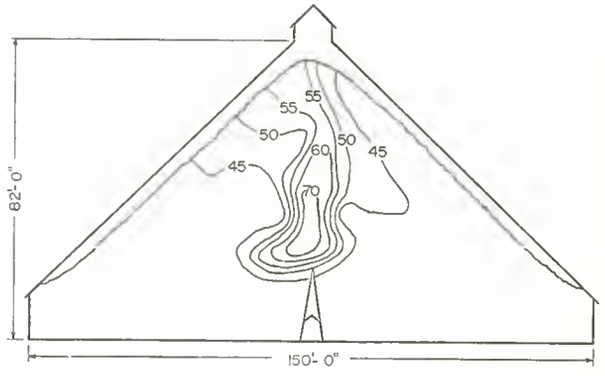

Figure 8. Cottonseed temperatures in large storage after 2,635 hours of fan operation.

been satisfactorily cooled. Figure 8 represents data taken on March 23, 1967, after 2,635 hours of fan operation. No further aeration occurred after this date.

The temperature data taken in this study indicate that the cottonseed nearest the outside of the storage cools first, even without lateral pallets, and that the cottonseed in the peak of the mass takes the longest to cool. This longer cooling probably results from a low airflow rate. Another possible factor in this regard is that this area is where the incoming warm cottonseed enters to fill the storage. Data taken n subsequent studies generally indicate a similar cooling pattern.

This paper is not intended as an aeration system design guide, but only to acquaint you with some of the work being done in commercial cottonseed storages. It is possible, however, that some changes would greatly improve the effectiveness and efficiency of your aeration system. It is hoped that this

paper may cause you to consider such changes.

Much work is being done toward improving aeration systems for and the storage of cottonseed. It is anticipated that some published reports on the subject will be available in the near future.

NEW COTTON VARIETIES

by

R. J. Miravalle
National Cottonseed Products Association, Inc.
Memphis, Tenn.
(Presented by D. E. Gandy)

Seed of three new cotton varieties are available for extensive commercial planting in the Mississippi Valley and Midsouth areas in 1969. These varieties are: 'Hancock', 'TH 149', and 'McNair 1032B'.

Seed of the University of Missouri bred variety 'MO-DEL' may be available in very limited quantities. Seed of the University of Arkansas bred variety 'Rex Smooth 66' are all earmarked for planting seed multiplication fields and experimental purposes and are not available for commercial production this year.

Coker Pedigreed Seed Co., Delta & Pine Land Co., and Stoneville Pedigreed Seed Co. have not introduced new cottons for these areas in 1969.

'Hancock' was bred and released by the University of Tennessee with the USDA cooperating. Stellar features of 'Hancock' are its earliness and higher yield. Its quality is in the "bread and butter" range. Planting seed of this variety are available from the Tennessee Crop Improvement Association, 810 Broadway, Nashville, Tenn.

'TH 149' was bred from germplasm developed by many people in the 'Triple Hybrid' research program at several locations and dates back to the late 30's. North Carolina State University with the USCA cooperating did the final breeding and release of 'TH 149'. This is a high quality cotton with a staple length in excess of 1-1/16 inches and a strength of over 90,000 Pressley. However, it is a poor yielder. Planting seed of 'TH 149' are available through both the North Carolina Crop Improvement Association, State College Station, Raleigh, N. C., and the McNair Seed Co., P. O. Box 706, Laurinburg, N. C.

'McNair 1032B' was bred by the McNair Seed Co. and released by them as a quality improvement over the original 'McNair 1032'. Its staple is a full 1-1/16 inches – an increase of 1/32 inch over '1032'. The micronaire value is approximately 0.5 unit finer than '1032' and averages about 4.0 Mike. In other features 'McNair 1032B' is essentially unchanged from the original variety. For local sources of planting seed contact the McNair Seed Co.

'MO-DEL' was bred and released by the University of Missouri. This is a quality cotton of average or slightly below average yield. This cotton is highly tolerant to Fusarium wilt and nematodes and excels on light soils where this disease and pest predominate. This cotton is early but not quite as early as 'Auburn M'. Most of the seed of 'MO-DEL' will be used to plant seed multiplication fields this year, but I understand some seed may also be made available for commercial planting. For information on availability of planting seed of 'MO-DEL', contact the Missouri Agricultural Experiment Station, Delta Center, Portageville, Mo.

'Arkansas 61-18' was bred and released by the University of Arkansas as 'Rex Smooth 66'. This is a storm-resistant boll type cotton which means that the locks stay in the burr permitting stripper harvesting but also fluff out well enough for spindle picking. Since this cotton can be stripped or picked it should not be classed as a storm-proof boll type. 'Rex Smooth 66' is early, has smooth leaf, and is a quality cotton with excellent yield performance. It is not tolerant to Fusarium or Verticillium wilt and thus planting on wilt infected soils is not recommended. Seed of this cotton are expected to be available for commercial planting next year.

'Rex Smooth 66' is the first varietal contribution to the "once-over" harvest concept made by a breeder outside of Texas and Oklahoma. Production costs must come down and reducing harvesting costs by stripping is one way of doing just that. Breeders and engineers have matched wits and come up with high quality "once-over" cottons and machinery improvements which were dreams 2 years ago. Other "stripper" varieties of even higher quality than 'Rex Smooth 66' include 'Coker 4104'm 'Dunn 56C', 'Tamcot 788'm abd 'TPSA 110' just to name a few of

the nearly fifteen such cottons presently available. Machinery improvements include brush harvesting and just last year a leaf, stick, and burr extractor was added to the harvester. Thus it is not only feasible but practical as well to grow a quality cotton, harvest the cotton in a "once-over" operation with a brush stripper, and leave the gin trash in the field by using a leaf, stick, and burr extractor attachment on the harvester and haul only seed cotton to the gin. The economics of production dictate that more and more storm-resistant cottons will be brush-harvested East and also West of the original Texas-Oklahoma stripper area. The major obstacle to this change is our own reluctance to accept new practices. Technically the change is feasible and practical. We stand at the threshold of such a change. It is coming with ever-increasing rapidity. As the cost-price squeeze gets tighter, the quicker "once-over" cotton production will be adopted.

It is difficult for me to see how monetary returns can be increased significantly through breeding for higher yields directly. In addition to the improvements possible by "once-over" harvesting just reviewed, it seems more likely to me that increased returns will come from breeding improvements in lint and seed quality, disease tolerance, and insect tolerance. Breeders' nurseries confirm my belief. In addition to lint quality improvement, two or more of the following morphological characters are being incorporated into the breeding materials by most breeders: glandlessness Frego bract, nectariless, okra leaf, and glabrous leaf (that is, a leaf without hairs). Next to lint quality, glandlessness ranks highest in priority of characters to incorporate into a cotton variety. The concept of total quality in both lint and seed is held widely among breeders. Of the morphological characters cited, glandlessness is by far in the most advanced state of varietal development. The release for commercial production this year of another glandless cotton, 'Watson GL 16', is indicative of this trend. 'Watson GL 16' appears to be more widely adapted than the first glandless variety, 'Gregg 25V'. 'Watson GL 16' is a storm-resistant cotton of good quality. Limited trial plantings in Arkansas last year were very encouraging. Trial plantings of 'Watson GL 16' in Arkansas, Louisiana, Mississippi, and Tennessee are planned for this year. You will be hearing about more glandless cottons next year.

Frego bract, nectariless, and okra leaf all convey tolerance to boll rots. In addition, Frego bract, nectariless, and glabrous leaf convey tolerance to the boll worm and budworm. Incorporation of these characters into new cottons will increase yield by protecting the cotton present and allowing it to "make." Some cost reduction can also be envisioned.

Repeated investigation of possible preference of budworms and boll worms for glandless cotton indicates that the rest of the genotype greatly influences this reaction and that any perferences demonstrated are not associated 100 percent with glandlessness.

Because of these findings and the push for additional sources of plant protein, in the last few years the idea held widely that insect problems would be greater with glandless cottons than with glanded ones has been replaced by much optimism for glandless cottons.

The glandless cotton-insect preference story could well be the subject of another talk; but, I think it suffices here to say that insects are not now considered to pose the threat to glandless cotton that was once thought. But please note that entomologists have by no means abandoned the study of glandless cottons. These cottons will remain the object of much investigation.

FLAME RETARDANT COTTON BATTING

by

N. B. Knoepfler
Southern Utilization Research and Development Division
New Orleans, La.

Research to improve the performance characteristics of cotton batting has been underway at the Southern Regional Research Laboratory since June 1961. This research was a joint undertaking of the USDA with the Textile Fibers and By-Products Association, the National Cottonseed Products Association, the National Cotton Batting Institute, and the Foundation for Cotton Research and Education aimed at the development of cotton batting products that could effectively compete with synthetic foams and other cushioning materials that were challenging cotton's position in this traditional market.

During the first 6 years of this work the primary effort was the development of products from cotton linters and textile wastes for cushioning applications that exhibited enhanced resilience, dimensional stability, tensile strength, and integrity. This research culminated in the Cotton Flote process (fig. 1) which is currently being used by 12 cotton batting manufacturers whose combined annual production capacity is estimated to be about 85 million pounds of product per year. Most of the production is going into automobile seating, with a small amount finding its way into mattresses and possibly furniture.

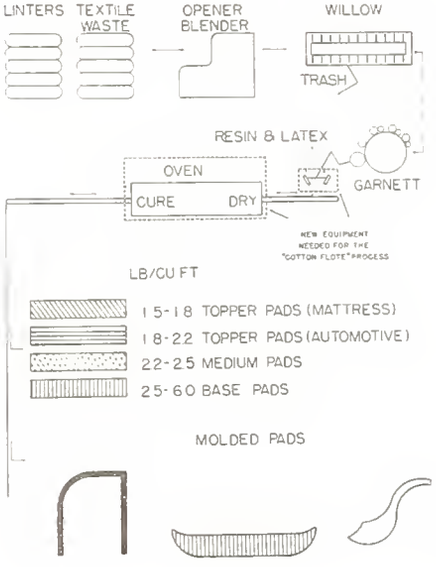

Figure 1.
Cotton Flote process.

The Cotton Flote process essentially consists of the simultaneous application of two different types of resins to the web of fibers as they are discharged from a garnett. The resins are applied as spray, following which the treated webs are lapped conventionally to the desired thickness or density, and the damp array then dried and cured on a continuous basis. As a general rule the spray consists of a water based mixture of both thermoplastic and thermosetting resins in equal proportions. The spray usually contains 20 percent solid matter. The amount of chemical added to the web is controlled by the amount of "wet add-on" that is used. Normally for products that range in density from 2.0 to 6.0 lb. per cu. ft. the weight of treating formulation sprayed onto the web equals the weight of the cotton in the web. This results in finished products that contain approximately 16.6 percent of the resins and 83.4 percent cotton fibers.

You will note from figure 1 that the mechanical processing of the fibers for the Cotton Flote process remains unchanged from that used for the production of conventional cotton batting. The only new equipment that is needed is a series of spray nozzles on each garnett, and a drying-curing oven at the end of the floor conveyor.

Both thermoplastic and thermosetting resins are used in the treating formulation. Each of these resins has a definite function insofar as the performance of the products are concerned. The thermosetting resin serves to improve the inherent resilience of the fibers much the same as the resins used in wash-wear or durable-press cottons to improve the resilience of the products. In fact, the resins used are the same family of resins as are used in wash-wear and durable-press cottons.

The thermoplastic resins used serve to bond the fibers together at points of contact within the batting array. These resins contribute tensile strength, dimensional stability, and integrity to the products (table 1).

Table 1. – Typical formulations used to spray the web in the production of Cotton Flote

Typical treating formulations		Typical treating formulations	
	20 percent resin solids		
Methylated methylol melamine	50 percent	Urea formaldehyde (modified)	50 percent
Vinyl acetate	50 percent	Vinyl acrylate	50 percent
Buffer or formaldehyde acceptor		Buffer or formaldehyde acceptor	
Catalyst (magnesium chloride)		Catalyst (magnesium chloride)	
Water		Water	
Methylol imidazolidone	50 percent	Methylated methylol melamine	50 percent
Vinyl acetate-acrylate	50 percent	Vinyl chloride-acetate	35 percent
Catalyst (zinc chloride)		Styrene butadiene	15 percent
Water		Buffer or formaldehyde acceptor	
		Catalyst (magnesium chloride)	
		Water	

This table shows some typical treating formulations that are being used by the batting industry in the production of Cotton Flote. In the first formulation, the thermosetting resin is methylated methylol melamine and the thermoplastic resin is vinyl acrylate; in the second formulation, the thermosetting resin is dimethylol dihydroxy ethyleneurea and the thermoplastic resin is vinyl acetate. There are, of course, many different thermosetting and thermoplastic resins that could be used in combination with each other, change the properties slightly one way or the other.

With regard to properties, then, let us see what has been achieved by the Cotton Flote process in comparison with conventional cotton batting and with polyurethane foam.

Let us first talk about resilience. As you are aware, the synthetic foam industry has capitalized upon what they describe as instantaneous recovery from compressive stress. While we do not subscribe to the hypothesis that such instantaneous recovery from loading is the essence of seating or mattress comfort, nevertheless such advertising has sold a lot of foam.

Figure 2 shows that conventional cotton batting when subjected to cyclic compressive loading at the rate of 1.5 lb./sq.in. recovers 65 to 70 percent of its original thickness in 4 min. when tested after exposure to 70° F. and 65-percent relative humidity for 24 hr. The Cotton Flote product recovers 90 to 95 percent of its original thickness in 4 min. while the polyurethane foam recovers between 98 to 100 percent of its original thickness in 4 min.

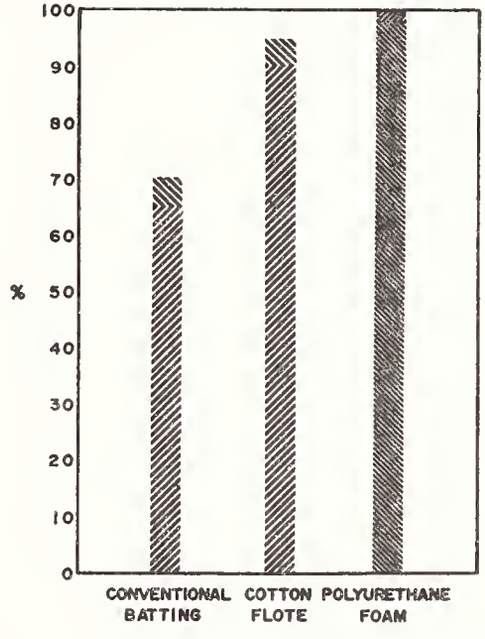

Figure 2. Recovery in 4 minutes, 70° F – 65 percent relative humidity.

When we evaluate the performance of these three products after exposure to 100 percent relative humidity at 80° F., we find that the conventional cotton batting regains only 50 to 55 percent of its original thickness 4 min. after loading is removed, while the Cotton Flote product regains 75 to 85 percent of its original thickness and the polyurethane foam again regains almost 100 percent of its original thickness (fig. 3). The cotton products, of course, continue to regain thickness with passing time – after 2 hours for example, the conventional cotton batting has regained about 60 percent of its original thickness while the Cotton Flote products have regained 90 percent.

At this point, let me show you one of the reasons that we made the statement a moment ago that we did not consider 100 percent recovery from loading in a short time as the most important criteria in cushioning comfort. We show here typical loading curves for conventional cotton batting Cotton Flote and polyurethane foam (fig. 4). Note that the con-

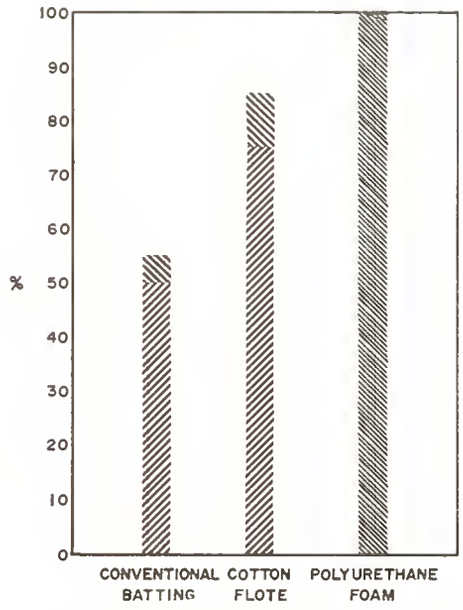

Figure 3. Recovery in 4 minutes, 80° F – 100 percent relative humidity.

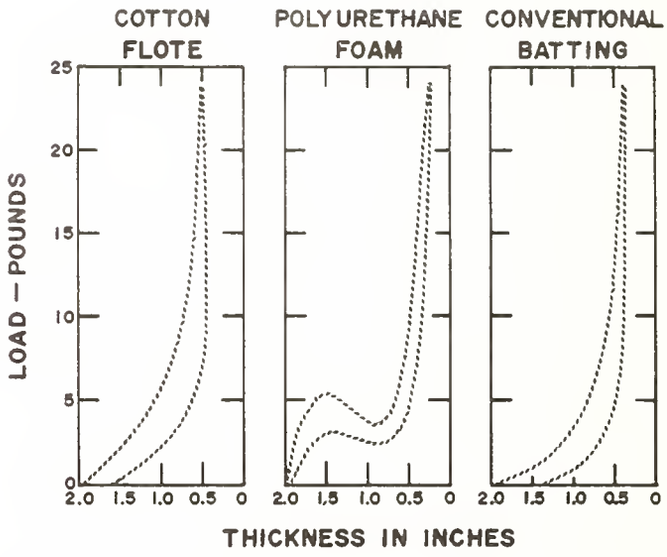

Figure 4. Loading curves.

ventional cotton batting responds to loading by smoothly compressing as the load increased, and then as the load is progressively removed, it expands to regain a proportion of its original thickness. Cotton Flote behaves in the same manner as the conventional cotton batting by smoothly compressing as the load increases. As the load is removed the Cotton Flote expands and recovers a much greater proportion of its original thickness than does conventional cotton batting. But now look at the loading curve for polyurethane foam. The curve starts out much the same as the two cotton products just described. Note that fairly early in the loading process the polyurethane foam collapses under the load, and then again starts up a smooth path. When unloading is measured, the same type of displacement takes place once the critical loading point is reached. The foam product then goes on to recover to almost 100 percent of its original thickness. This deflection in the loading curve for foam products is called "bottoming out" and is characteristic of foam products.

Let us now turn our attention to tensile strength. This is one of the properties of conventional cotton batting that gives problems in the fabrication of automobile seating, mattresses, and furniture (table 2).

Table 2 – Tensile strength of 1 in. thick Cotton Flote

Density	Machine direction	Transverse direction
lb./cu.ft.	lb. to break	lb. to break
1.0 - 1.5	7.5	4.5
1.5 - 1.8	10.0	6.0
1.8 - 2.2	15.0	10.0
2.2 - 3.0	25.0	15.0
3.0 - 4.5	40.0	25.0
4.5 - 6.0	65.0	35.0

Conventional cotton batting of 2.0 lb. cu. ft. density has a nominal breaking strength of approximately 4.0 lb. in the machine direction and about 2.0 lb. in the transverse direction when measured using a sample 1.5 in. wide. Cotton Flote products of comparable density have a tensile strength of 15.0 lb. in the machine direction and 10 lb. in the transverse direction. As the density of the two products increases the tensile strength in both directions also increases. The Cotton Flote product has four and five times the tensile strength of the conventional untreated cotton batting. The Cotton Flote products also have the advantage of dimensional stability and integrity. They can be die-cut into predetermined shapes and sizes to fit cushion design. They retain their shape and size even with rough handling during fabrication, and they can be hog-ringed directly to springs or stapled to frames for furniture or box springs. In addition, the Cotton Flote products do not tend to compact upon use as does conventional cotton batting as a result of the shifting of the fibers within the array.

As the research project that led to the development of Cotton Flote was coming to an end, considerable attention was focused upon another desirable property for cushioning materials that had been examined in depth during the research.

As you are no doubt aware, in late 1967 the Congress of the United States passed several laws that will one day very soon directly affect cotton batting manufacturers. I refer, of course, to the amendments to the Flammable Textiles Act and to the Highway Safety Act.

These laws deal with the flammability of materials being used in automobile interiors and in furniture and bedding.

In anticipation that flame retardancy would some day be required in cotton batting products to meet the laws, the research team embarked upon a study aimed at determining if Cotton Flote could be made flame retardant without deleteriously affecting the good properties that had been built into the product.

The essential criteria for flame retardance-treatments for Cotton Flote are low cost, because the finished product must sell for between 20 and 40 cents per pound. The treatment should, if possible, be applied from a water system to avoid any additional fire hazards in the batting plant. In addition, since the chemicals for the Cotton Flote system are applied from a water-based system, it would be highly disirable to apply the entire treatment including flame retardant at one time. The treatment should be effective on the fibers as they are received and processed in a batting plant to avoid the necessity for scouring to remove unwanted waxes, pectins, and other extraneous foreign matter that usually accompanies cotton fibers of the type used in batting. Because cotton batting products are used under constantly varying environmental conditions, the treatment should resist removal by high humidity and high temperature, and should be durable to mild leaching such as might occur from perspiration, spillage, or liquids and the like. To keep the cost as low as possible, the amount of flame retardant needed should be as small as possible. Since many of the chemicals that confer flame retardance can possibly form undesirable odors under certain conditions, care needs to be exercised to select the chemical to avoid the production of odoriferous byproducts. Some chemical systems, such as borax, are quite effective in reducing flamming, however, cotton products treated with borax usually exhibit an afterglow that persists for a long time. This is undesirable since the glow temperature is generally several hundred degrees hotter than the flame. The final item means that we want to be sure that the chemicals do not affect the health of either the personnel manufacturing the item, or the eventual owner of the product by causing allergies or by being carcinogenic.

Now we have a few of the "must nots" that the treatment has to meet. We do not want the treatment: (1) to absorb water from the air; (2) to adversely affect the resilience or the tensile strength of the products; (3) to interfere with the moisture absorption-desorption characteristics of cotton fibers, because this is indeed one of cotton's comfort factors; and (4) to interfere with the air permeability of the array; because cotton batting functions like a bellows in pulling air in during expansion and expelling air upon compression.

Our first concern was to establish a means of measuring what we considered to be the most important performance characteristics and to define what we mean by effective flame retardance.

There are quite a number of test procedures available for measuring the rate of burning, of flame retardance, and of self extinguishing characteristics that have been accepted by the textile industry for many years.

Because we believe that for our research products we should select the most demanding test procedure, we chose to evaluate the products using a modification of the American Association of Textile Chemists and Colorists procedure 34-1964. This test involves hanging a sample 2 inches wide by 10 inches long vertically over a bunsen burner. Samples are usually 1-inch thick. The flame from the bunsen burner is 1½ inches high and the sample is adjusted to project three-fourths inch into the flame. The flame burns for 12 seconds. We measure the time that the flame persists after the bunsen burner is extinguished and the time that the red after-glow persists. We also measure the length of the main charred spot at the bottom of the sample and the overall char length including scorch from flashing. By these measurements we are able to differentiate between the effectiveness of a number of treatments to the point where we can with reasonable confidence, select samples having different degrees of flame retardance. Since there is also the question as to flame retardance under a number of environmental conditions, we usually test the samples after (1) conditioning at 70° and 65 percent R.H. for 24 hours, (2) 100° and 100 percent R.H. for 3 days, (3) 158° for 16 hours, (4) after soaking with water and drying at 158° F. for 16 hours. At a later date we also plan to go back and test samples that have been stored in our pilot plant from 6 months to 1 year after manufacture to ascertain if the flame retardance is being lost.

Chemical systems – There are a number of chemical systems that improve the ability of cotton fibers to withstand oxidative decomposition. Among these are APO (tris[1-aziridinyl]phosphine oxide). THPC (tetrakis-[hydroxymethyl]phosphonium chloride), and BPP (tris[2-3-dibromopropyl]-phosphate). Unfortunately, these compounds sell for about $1.00 per pound and chemical add-ons of 10 to 20 percent are needed for cotton batting products, depending upon the density.

For economic reasons we had to seek effective flame retardants that would cost no more than 30 cents per pound. These compounds had to be effective at add-ons of less than 10 percent by weight. We, therefore, considered the inorganic borates, ammonium phosphates, urea phosphates, phosphorous containing derivatives of dicyandiamide, and borated amido polyphosphates. A number of these had to be more or less eliminated from further consideration for one or more reasons. For example, the inorganic borates and the inorganic ammonium phosphate salts tend to be lost from the system under conditions of high relative humidity and where the sample had been subjected to soaking with water. In addition, most of the borate salts give products that exhibit a tendency to glow after the source of ignition is removed. The urea phosphate, the borated amidopolyphosphates, and the phosphorous derivatives of dicyandiamide gave promising results as can be seen in table 3.

Table 3 – Chemical composition[1] and resilience characteristics

Item	Sample A	Sample B	Sample C	Control
Thermosetting resin	MMM	MMM	MMM	MMM
Percent add-on	37.5	37.5	40.0	50.0
Thermoplastic resin	CL-ACRY	ACRY	ACRY	ACRY
Percent add-on	37.5	37.5	40.0	50.0
Flame retardant	BAP	DCP	UP	–
Percent add-on	25.0	25.0	20.0	–
Density lb./cu. ft.	2.0	2.0	2.0	2.0
Cyclic loading recovery[2]				
65 percent R.H.	95.3	94.3	92.2	93.7
100 percent R.H.	73.0	75.5	75.8	71.6

[1] MMM = methylated methylol; CL-ACRY = vinyl chloride acrylate copolymer; ACRY = acrylate polymer.

[2] After 4 minutes.

These are some typical formulations that we found to impart an acceptable degree of flame retardance. You will note from the percentages that we used that, in general, the ratio or thermoplastic resin to thermosetting resin remains essentially equal to one in the better products. In table 3 the MMM stands for methylated methylol melamine, the CL-ACRY represents a vinyl chloride acrylate copolymer, the ACRY an acrylate polymer. For sample A the flame retardant used was borated amido polyphosphate which has been coded BAP. For sample B the DCP represents the phosphorous derivative of dicyandiamide, and for sample C the flame retardant designated UP was a urea phosphate complex. Each of these seem to meet the criteria as given above. The price range is from 20 to 30 cents per pound for these chemicals. The addition of the flame retardant to the Cotton Flote formulations did not adversely affect the resiliency of the product when compared to the control shown in the last column.

Now let us look at the flame-resistance characteristics of the products (table 4). It can be seen that when the samples were conditioned at 70° F. and 65

Table 4 – Flame retardance characteristics

Item	Sample A	Sample B	Sample C	Control
70° F. - 65 percent relative humidity:				
Afterflame . . . . . sec.	0	0	0	3
Afterglow . . . . . do.	0	0	0	21
Overall char . . . . . cm.	2	8	5	12
Main char . . . . . do.	1	5	4	8
100° F. - 100 percent relative humidity for 3 days:				
Afterflame . . . . . sec.	0	0	0	9
Afterglow . . . . . do.	0	0	3	46
Overall char . . . . . cm.	2	6	3	13
Main char . . . . . do.	1	4	1	8

percent relative humidity and then tested for flame retardance that samples A, B, and C had no afterflame, that is to say that the products were self extinguishing immediately upon removal of the external flame source. Note that the control Cotton Flote sample took 3 seconds to self extinguish the flame, and it continued to glow for 21 seconds. If we compared these samples with a sample of conventional untreated cotton batting, we would find that the conventional batting would burn its entire length.

The overall char and main lengths that we have more or less arbitrarily set as the limit were well below the level of 15.25 cm. However, the control sample without the flame retardant had a considerably greater char lengths than did samples A, B, and C. After the samples had been exposed to 100-percent relative humidity at 100° F. for 3 days, we find that this rather tough set of conditions did not change the flame-retardance performance of samples A and B. Sample C and the control did show significant change. In the case of sample C, it would still be acceptable; however, the 3-second afterglow observed would make the sample somewhat suspect over an extended period of use. For the control 5-second afterflame, the arbitrary maximum we allow, and the 46-second afterglow, where we also have established a 5-second maximum permissible, would cause the sample to be rejected. The overall char is also approaching the maximum permissible.

Table 5 shows the performance of the samples after they have been soaked with water to the maximum that they will hold, then the samples are dried at 158° F. and tested for flame retardance. Here again samples A and B were essentially unaffected by this procedure, but sample C and the

Table 5 – Flame retardance characteristics

Item	Sample A	Sample B	Sample C	Control
158° F. - 16 hr. (dry):				
Afterflame ..... sec.	0	0	0	2
Afterglow ..... do.	0	0	0	5
Overall char ..... cm.	2	15	6	16
Main char (cm.) ..... do.	1	8	2	6
158° F. - 16 hr. (wet):				
Afterflame ..... sec.	0	0	2	5
Afterglow ..... do.	0	0	5	3
Overall char ..... cm.	2	8	5	11
Main char ..... do.	1	5	3	9

control were affected. Note that the performance of the control appears to have actually improved by the soaking and drying. This is probably due to a better distribution of the chemicals in the batting. Under this test procedure the sample C shows some afterflame, although it would be acceptable under our permissible limits. The last four lines of table 5 show that exposing the samples to 158° F. for 16 hours did not significantly change the performance of samples A and C in comparison with the test results shown in table 5, but did affect the performance of samples B and the control. Note that for sample B the overall char length is approaching the maximum permissible, and for the control it has exceeded this limit. It should be pointed out that, by making minor chemical modifications in the flame retardants used for samples A, B, and C, we have been able to improve the performance of samples of Cotton Flote made with them so that they are acceptable under all test conditions. One company is already marketing flame-retardant mattresses and box springs based upon these research findings.

Flame retardant conventional cotton batting: In our latest research we are at present directing our attention to means of imparting flame retardance characteristics to conventional cotton batting. A new cooperative research project, having the same sponsors as the work that led to the development of the Cotton Flote process, was initiated in April 1968.

The requirements for the application of flame-retardant characteristics to conventional cotton batting are considerably different than those that apply to the Cotton Flote system, although many of the same chemical compounds can be expected to do the job effectively. For example: In the Cotton Flote process the bonding of fibers together at points of contact is a desirable characteristic that assists in maintaining the tensile strength, dimensional stability, and integrity of the products. In addition, the presence of the thermoplastic resin that serves as the bonding agent makes the removal of the flame-retardant chemicals more difficult at high relative humidity and even mild leaching. Furthermore, all of the needed chemicals are applied in an operation already incorporated into the process and the fibers are in an open array and readily accessible to the treating formulation.

For conventional cotton batting there seems to be no real good place to apply the flame retarding chemicals to the fibers during normal mechanical processing. For this reason it appears that flame-retardance treatments must of necessity be applied as

a pretreatment before any mechanical processing of the fibers is undertaken.

The treatment for rawstock must meet essentially the same criteria that was listed for the Cotton Flote process – that is, it must be inexpensive, easy to apply, effective on native linters and waste, effective at low levels of add-on, durable to mild leaching-high temperature-high humidity; it must be odor free in the finished product, effective in reducing afterglow, and physiologically inactive.

Here we see what the treatment should avoid and these requirements are where the treatment for rawstock differs from the requirements for Cotton Flote. The chemical used should not pick up water from the atmosphere and cause the fibers to become soggy and thus lose resilience. The treatment should not change the physical characteristics of the fibers to the point where an inferior quality garnetted web is the result. The treatment should not embrittle the fibers or bond them together to the point where large amounts of fibers are broken during garnetting. The treatment should not affect the ability of the fibers to adsorb and desorb moisture. The treatment should not "deaden" the fibers to the point where they pack down and thus reduce the air permeability of the array. Finally, the treatment should not dust or powder off during mechanical processing, or be lost because of migration, dissolution, sublimation, dusting-off, or other means during the useful life of the finished particle.

There are a number of ways that chemical systems could be applied to the fibers to achieve adequate impregnation with the flame retardant. Among these are spray flooding followed by dewatering by squeeze rolls or centrifugation, pressure impregnation such as is used in rawstock dyeing, and immersion followed by appropriate dewatering. We have only evaluated the last alternative in any depth.

The usual procedure followed to prepare flame-retardant samples was as follows:

A blend of fibers consisting of 60-percent Delta first cut linters and 40 percent of various grades of textile wastes (fly, picker, motes, sweeps) was prepared on our cotton fiber blending equipment at the laboratory. The fibers were processed into a 16 oz./sq. yd. picker lap for ease of handling. The picker lap was separated into 10-inch widths and encased in gauze, again to facilitate handling on the processing equipment available to us. As a general rule individual samples for treatment weighed between one-third and one-half pound.

The treating solution, approximately 3 1/2 to 4 pounds, was made up to contain a calculated amount of solids of the treating chemical. The gauze encased picker lap was passed through the treating solution with some hand manipulation, thence through a set of squeeze rolls following which the sample weight was checked to ascertain the approximate wet add-on. The wetted sample was then repassed through the solution and through the squeeze rolls which had been adjusted to give a wet pickup of approximately 100 percent by weight of the cotton to the existing sample.

The wet samples were then dried (and in some cases cured) in a cabinet-type oven. Where drying only was carried out, the samples were removed from the oven when their moisture content was between 10 and 12 percent by weight. The drying conditions seem to be somewhat critical. If high temperature air (over 220° F.) were used, an undesirable amount of migration of the chemicals to the surface of the picker lap usually resulted. As a consequence, the interior of the samples were deficient in flame retardance. All samples were air-equilibrated for at least 24 hours before they were garnetted and made into cotton batting products for test purposes.

Table 6 shows the flame-retardance characteristics of four typical samples of cotton batting that had been pretreated to make the fibers flame resistant. Sample D contained 7.5 percent by weight of a borated amido polyphosphate; Sample E contained 8.1 percent by weight of a phosphorous derivative of dicyandiamide; Sample F contained 10.1 percent of a propyl ammonium phosphate; Sample G contained 5.3 percent of a urea phosphate complex.

Table 6 – Flame retardance characteristics

Item	Sample D	Sample E	Sample F	Sample G
70° F. - 65 percent relative humidity:				
Afterflame . . . . . sec.	0	0	0	0
Afterglow . . . . . do.	0	0	0	0
Overall char . . . . . cm.	2	6	4	7
Main char . . . . . do.	1	2	2	2
100° F. - 100 percent relative humidity (3 days):				
Afterflame . . . . . sec.	0	0	0	0
Afterglow . . . . . do.	1	0	0	0
Overall char . . . . . cm.	1	6	3	8
Main char . . . . . do.	1	2	2	2

You will note that all of these samples have excellent flame retardance. When tested after conditioning at 70° F. and 65 percent relative humidity, they all self-extinguish upon removal of the external source of flame. All samples except D exhibit no afterglow. Sample D has only a one second afterglow. All have overall char lengths well below the arbitrarily permissible 15.25 cm. The small differences between the overall char length and the main char length indicate that the samples had little or no propensity to flash. In contrast, a sample of conventional cotton batting burned its entire length after conditioning at 70° and 65 percent R.H., and after conditioning at 100° and 100 percent R.H.

Table 7 shows the samples tested for flame retardance after they were soaked with water and dried at 158° and after being exposed to 158° F. for 16 hours without being wet out.

Table 7 – Flame retardance characteristics

Item	Sample D	Sample E	Sample F	Sample G
158° F. - 16 hr. (dry):				
Afterflame . . . . . sec.	0	0	0	0
Afterglow . . . . . do.	2	0	0	0
Overall char . . . . . cm.	1	6	2	8
Main char . . . . . do.	1	2	2	2
158° F. - 16 hr. (wet):				
Afterflame . . . . . sec.	0	0	0	0
Afterglow . . . . . do.	1	0	0	0
Overall char . . . . . cm.	3	4	5	4
Main char . . . . . do.	1	2	2	3

In these tests all samples showed no afterflame at either test condition. Only sample D showed any afterglow, and this was 2 seconds in the dry 158° storage, and 1 second when dried at 158° F. after being soaked with water. All samples had minimal char lengths, both overall and main char.

Based upon these test results all samples pre-impregnated with flame retardants as shown would be acceptable flame retardant for cushioning applications. A sample of conventional cotton batting burned its entire length after being wet out and dried at 158°, and after being exposed to 158° F. for 16 hours.

Summary and conclusions – From the data presented, we can conclude that there are a number of chemical systems that will confer a significant degree of flame retardance to Cotton Flote and to conventional cotton batting. The economics of the treatment seem to be within reason with the chemicals costing from 20 to 30 cents per pound, and add-ons needed between 5 and 15 percent by weight of the cotton fibers treated.

The chemical systems that we have evaluated so far seem also to meet the criteria of permanency, resistance to removal by elevated temperature, mild bleaching, high relative humidity, lack of physiological affect, and relatively ease in applying from a water system.

Based upon the test results from this research, there is every reason to believe that cotton batting products that demonstrate an acceptable degree of flame retardance can be produced on a commercial scale. Cotton Flote products having high flame-retardance characteristics are already being produced commercially.

NEW SOURCES OF OILSEEDS

by

D. E. Gandy
National Cottonseed Products Association, Inc.
Memphis, Tenn.

The potential new oilseed crops which can be grown in certain areas of the Cotton Belt include castor beans, crambe, safflowers, sunflowers, sesame, and rape. Of these, sunflowers show the most promise. The prospects for an expansion in other oilseed production depend to some degree on the existing total capacity of the industry and the industry's current operating level.

First, I should comment on why the Cotton Belt or the Southern area of the United States is interested in the development of other oilseed crops. This area should have a distinct market advantage because many cotton oil mills have surplus crushing capacity that could be used in processing sunflowers. Many of the farms in the Cotton Belt have a need for an additional new cash crop to utilize idle acreage or to replace presently grown marginal profit crops.

Sunflowers

Sunflowers are profitably grown, as an oilseed, in some countries. They probably can be grown profitably in some or in all parts of the South. For the first time in Cotton Belt States in 1968, sunflowers were widely grown in trial plantings on commercial farms. Yields varied widely, but the experience resulted in observations that gave hope and assistance to those who are interested in growing the crop.

These observations indicate the crop has considerable promise. However, experience from other areas and 1 year's attempt in commercial practice in the Cotton Belt States do not provide adequate information from which conclusions can be drawn. Therefore, most interested individuals believe that one or two additional years of trial plantings are needed. Admittedly, some growers are sufficiently convinced of the value of the crop that they are willing to risk their land, labor, and capital for larger acreages.

Those who are interested in growing sunflowers should recognize that the following demonstrated principles must be followed. Those who are unable to observe these principles are taking unnecessary risk of land, capital, and labor and may damage the promising future of the crop.

Like other crops, sunflowers demand proper management and respond very poorly when the management practices are neglected.

An available market is the first requirement for success.. The prospective grower should discuss marketing with oilseed processing mills or other interested potential buyers. Farmers will find it advantageous to work in community or area groups with their oil mills to make available a supply of seed sufficient to justify processing run(s) and to secure the benefits of mutual exchange of information and availability of supplies and services. Each oil mill will analyze its particular situation to determine whether it can offer a market or has a need for additional raw materials for processing.

High fertility and adequate moisture on good soil give best plant response. It was observed that sunflowers will not thrive on acid, waterlogged, shallow, or stiff soils. Arrangements should be made well in advance for certified planting seed of the best adapted variety.

Insects, especially the sunflower head moth (**Homoeosoma electellum**) can be damaging and arrangements should be made well in advance for adequate control at the proper time. Losses can be disastrous if control is omitted or delayed. Acreage should be large enough to justify aerial applications since plant height prevents use of ground machines. Severe bird damage is lessened by selecting open fields away from woods and water and by prompt harvest. This damage, which is no greater than with other seed grains grown under similar conditions, is usually less per acre when extensive acreage is grown. As for diseases – Verticillium wilt and sunflower rust are the most prevalent and best controlled by planned crop rotation and location away from wild sunflowers. Sunflowers should not follow sunflowers or other wilt susceptible crops and wild sunflowers appear to be the source of rust.

Availability of a satisfactory combine, equipped with a sunflower harvesting attachment, for immediate use when seed are ready for harvest is essential. Avoidable harvesting errors have caused losses of more than 50 percent of the seed produced.

Detailed records are necessary for adequate evaluation of the crop as a guide for improvement of production practices in the future. Whether the crop can be produced competitively with other crops on land not used by cotton will be determined by yields, production costs, and economies of product markets whenever they might be grown in adequate volume.

Safflower

Safflower is well established and adapted to the winter and spring climate of the Southwest and the Far West. Safflower seed provide an edible oil and the meal provides protein supplement for livestock; but the processing of seed has experienced problems in cotton oil mill operations. After experiencing difficulties caused by a drastic drop in oil price, the crop has, over the past 20 years, increased in a normal, healthy manner. The competition from sunflower oil in foreign markets recently has been a disturbing factor.

Future acreage will be influenced by the demand for safflower oil. It will also be influenced indirectly by government programs on cotton, soybeans, and feed grains.

Breeding programs are giving emphasis to the development of varieties having a lower percentage of hull and a higher oil and protein content. An effort also is being made to increase yield, improve cold and salt tolerance, and increase disease resistance. The technique for producing hybrid safflowers has been developed and hybrid varieties are in the testing stages.

Crambe

Crambe attracted the attention of farmers in Louisiana during the past 2 years, but the results were very disappointing. The fall plantings were damaged severely by winterkill, excessive rainfall, and diseases. Insufficient data are available to recommend any widespread planting of crambe, according to Tom Burch, Extension Agronomist for Louisiana State University. Much remains to be learned about its culture. Research will continue to determine what place, if any, crambe has as a crop in Louisiana. Marketing arrangements should be considered before planting crambe. Prospective growers are cautioned that, as with any new crop, many problems can and probably will arise. Therefore, any plantings made should be limited in size and should be looked upon as trial plantings since the markets for crambe as an industrial crop are limited. Crambe is in the same family as mustard and rape and will grow in almost all areas where wheat is grown.

Castor

It is strongly advised that castors not be planted unless adequate facilities for harvesting and marketing the crop are assured. Castors have been planted successfully in all cotton growing areas with the exception of areas where root rot is a problem. The crop is adapted in areas of low humidity and requires a growing season of 120 to 160 days to produce satisfactory results. Castors are now a competitive cost crop in certain areas since the development of high yielding dwarf and hybrid varieties and efficient harvesting methods. There are only two active processing plants in the United States. One is located in Plainview, Tex., and the other in Bayonne, N. J. Castor oil is used in ever increasing quantities as a chemurgic raw material. The meal is a byproduct. The pomace or meal has normally been used as an organic fertilizer. Recent research developments which show that the toxic material (ricin) which the pomace contains can be deactivated are encouraging because such detoxified castor meal may be used in cattle feeds.

Sesame

Commercial plantings of sesame have been made for the bakery and confectionery trade. It is doubtful that sesame will be raised for the production of oil unless high yielding indehiscent (nonshattering) lines are available which can be completely handled mechanically. Sesame gives much promise if these obstacles can be overcome. California and Mexico have shown an increased interest over the past several years in increasing its production.

Rapeseed

The rapes are well adapted to temperate regions where they may be grown as a winter crop. In 1967 and 1968 experimental trial plantings were made on the High Plains. Yields varied from a total loss up to 1,400 pounds per acre harvested. An experimental run was successfully made at the Levelland Vegetable Oil Company, Levelland, Tex., in 1967. Again, rapeseed is a specialty crop produced for the industrial use of the oil with the meal as a byproduct. It appears that some rapeseed meal can be safely incorporated in most animal rations when the economics of the product will justify its use. Interest in the crop has failed to develop with no experimental trial plantings indicated for 1969.

Summary

The surplus crushing capacity available creates a need for new oilseed production. It appears that the future production of any given new oilseed crop will be limited to certain areas. Soybeans are firmly established in the South and safflowers in the Far West. Acreage of castor beans, crambe, sesame, and rape will continue to be limited because of their being classed as specialty crops. With increased knowledge of improved production and harvesting practices and improved varieties, higher yields can be expected at unit costs which will make production economically feasible. The production cost and economies of product markets will determine which of the new oilseeds will develop to a position of agronomic importance. Preliminary observations of trial plantings of sunflowers in 1968 indicate the crop has considerable promise. Experience, however, from other areas and 1 year's attempt in commercial practice in Cotton Belt States do not provide adequate information from which firm conclusions can be drawn. Therefore, most interested individuals believe that one or two additional years of trial plantings are needed. Admittedly, some growers are sufficiently convinced of the value of the crop that they are willing to risk their land, labor, and capital for larger acreages in 1969. I see no reason for the crop not to become of increasing economic importance in certain areas of the South when volume production is achieved.

PANEL DISCUSSION: POTENTIAL PRODUCTION OF SUNFLOWER SEED

E.A. Gaulding Jr., Buckeye Cellulose
Corp., Memphis, Tenn.

PROCESSING OF SUNFLOWER SEED BY EXPELLER TECHNIQUES

by

J. W. Kidd
Farmers and Ginners Cotton Oil Co.
South Birmingham, Ala.

It was with pleasure, but at the same time, with some misgivings for me to accept the opportunity to talk to you today regarding the handling and processing of sunflower seed.

First, I would like to impress upon you that the small tonnage that we crushed and the manner in which we crushed it is not sufficient to arrive at any definite conclusions. Being the first crop grown in the area and delivered to us you can well imagine the variable conditions of seed received at the plant from a standpoint of moisture, heat, trash, and perhaps a few other things. However, we did receive quite a few hundred tons--and before receiving the crop we knew that we needed precleaning before storing. Unfortunately, we set up our precleaning on the wrong basis. Having had no experience, we thought that the trash was probably going to be large pieces of head, and so forth, which was not the case. The trash in seed that gave us a problem consisted of certain weed seed and green chaff which, of course, being of high moisture and being green caused the sunflower seed to become hot. In many cases and anytime we received a hot load of seed of such nature, they, of course, contaminated any seed in storage along with them. We attempted to crush as quickly as possible any small tonnage of seed on hand to prevent further increase in contamination. The seed that we actually received were not held in storage any length of time. From the seed house to the mill, our cleaning consisted of seed reel which is 5 x 18 ft. with metal openings 5/32nd of an inch. This reel with this metal size will remove practically all of the dirt and small trash. As a result of the cleaning job that the reel did we shall, in the future, for our prestorage cleaning, utilize the same size metal as used in the reel. We feel that following precleaning the seed can possibly be stored satisfactorily with the use of air as a cooling factor.

The late seed crop that we received handled very well even without the precleaning. However, I would not wish to have too large a tonnage of sunflower seed in storage at any time unless they were precleaned.

After the seed were delivered to the mill, from the cleaning reel, we did not find it necessary during the first period of crushing to utilize Bauer Brothers shaker. However, we do recommend that the Bauer Brothers shaker be used on any future crush of sun seed. We feel that the shaker should have a metal 1/4" in size to remove any larger particles such as stem and head.

From here to the hullers--We, of course, made a number of experiments at our hullers regarding metals and speed. The seed being of the nature described above, we were only able to do a job of decorticating and separation with the following set-up:

We removed the top row of the metals entirely and blanked the first section on the lower shelf. On the remaining section we used 1/2, 5/32, 5/32, 1/2, and 1/2 inch openings in the screens. We found that the best speed to run the huller fan was at 1,640 r.p.m., huller speed at 1,150 r.p.m., shaker speed at 350 r.p.m. We had some problems in decorticating because the seed, in most cases, were prone to be soft, and separation was poor because of the moisture content in the hulls. From the huller, we put the hulls through a hull beater with metal sizes 1/4, 5/32, 5/32, and 5/32 in. This did a reasonably good job in separating piece and fine meats. We encountered a little problem with the hulls, particularly with the set soft seed. We did a better job in all respects when

seed moistures were lower and the seed were in better condition. From the hullers we found that we could not successfully roll the type of seed that we had. We therefore, blocked up the two top rolls and set them with an opening of between fifteen and twenty thousandths of an inch. We did a fair job of rolling with the above procedure, having a product of one consistency going to the cookers. We noticed with high moisture and damaged seed very little increase in fatty acid in the meat bin and at the cooker feed. I might remark here that, in my opinion, the sunflower meat is a very stable product as compared with certain other seed. It goes without saying that we tried, on the various runs made, definite procedures in cooking. We were told earlier by some experienced people that we would not have to cook with high temperatures; however, we found that it was necessary to cook pretty hard. We obtained some 160° to 165° F. temperature in the top kettle. We think the bottom kettles should be as hot as 255°, that 265° to 276° would be better, provided, of course, the charge is not so large that the meats remain in these temperatures an excessive length of time.

Our cookers are 100 inches, six high, French cookers.

In the intermediate kettles we used whatever steam was necessary to obtain as high a meat temperature as we could in preparation for the presses. After the first one or two trial runs, we used no water, and found that we did a much better job preparing the meats for the press. We found that the temperatures used above in cooking did not damage the oil. Our oil production passes through and over screen tank with removal of heavy foots before filtering. Oir oil is filtered by using paper over cloth, and the operation is exactly comparable with our cottonseed operation. The oil filters excellently and was found to be clearer when more cooking and the higher temperature were obtained in the meats for pressing.

Under normal conditions, applicable in this case, the cake is delivered to bins for storage and grinding. Since the cake was not as hot as cottonseed cake, we looked for no problem in storage before grinding. However, we found that sunflower cake did not react like cottonseed cake. In the second run, we had a fire in the cake bin, but it was not of much consequence as we lost possibly only 100 pounds of cake because of combustion. The cake bins are aircooled by fans similar to those used for cottonseed. After a second fire which was in the storage bins, we decided that we would grind the meal promptly rather than hold in storage as we do not have a cake and meal cooler. We followed this procedure on the remaining runs.

After several days we noticed an odor near the stacks of sunflower meal. Upon investigating we discovered that where the stacks were stacked upon each other, in one or two spots, heat was present. Actually, the sacks and the meal for an inch or two down into the sacks seemed to be charred with a charcoallike appearance. We could not understand this as the meal, upon checking, was only warm and probably at 20° to 30° lower temperature than cottonseed meal in sacks under similar conditions. We found on investigating through various sources, that a reaction of some type takes place between the meal and the sack because of the type of fat or wax. We were told that this same type of thing has happened in the past, particularly in the earlier days in linseed processing. I am just reporting this to you, however, as it will be something for us to watch not only in sacking but in bulk shipping.

After several days' aeration, we had no trouble whatsoever once the meal was cool and stacked. To whip the above problem, the cake can be cooled before grinding. If this is done, in my opinion there will be no problem from this direction.

Sunflower seed handle very well during processing, particularly in the transmission and handling equipment and in the cooker itself. We found after each run and at the end that it was never necessary to clean out any equipment, conveyor, or cooker, as we have had to do on cottonseed. It is the cleanest handling product, I believe, that one can crush.

I should like to point out a few things with reference to the quality of sunflower oil that we produced. We did not by any means have high quality seed. We had quite a number of oil analyses run during the operation, the best of which was 1.4 fatty acid, with a cup loss of 4.4,neutral oil loss of 2.09 with a refined bleach color of 1.2 red and refined color 2.2 red. The highest in the series ran 3.3 fatty acid with a neutral oil loss of 4.07 and a refined bleach color of 1.5. We did not run a cup loss on this as we had discontinued the use of this method

because of difficulty in getting solid foots residue. At the completion of our operations, we shipped out our sun oil with analyses of 3.21, neutral oil loss, refined bleach color 1.5, moisture and volatile matter 0.27, and fatty acid of 2.4. Based on the average of our analyses and oils through the production period, we do not feel there was any increase in fatty acid or decrease in quality of this oil as our oil shipped out as good or better than the average daily samples. The oil itself was no problem, so far as we found, to filter and handle. We do not feel there will be any problem in storage of crude oil as it seems to be a highly stable fat.

I do not have much to say in reference to protein, other than that because of the seed quality and poor separation, which we accomplished under poor seed conditions, there is much to be improved. Our meal ran an average of from 36 to 38.5 percent protein which, of course, we were forced to tag and sell as 36-percent protein sunflower seed meal. Those who tested the meal on a small scale reported back that the cows ate rather lustily and seemed to do well on the sunflower meal and hull mixture which, I am sure, had an additional ingredient of grain or ground corn.

The one product we thought would be a major problem in selling was the hulls. We had absolutely no problem with the hulls and would like to have had 1.000 tons to sell. We continue to get inquiries for the hulls in fairly substantial quantities. Our 36-percent protein meal ranged very widely in the oil content, partly because of lack of efficiency and experimenting with varying procedures in cooking, hulling, and separation. Our oils ran from 6-1/2 to 7 percent to as high as 9 to 9-1/2 percent. I did not run weighted averages on the various runs but our meal would average somewhere in the neighborhood of 7-1/2- to 9-percent fat. We took our hulls and ground them with our fiber mills, which gave a very nice looking, easy to handle product, which we sacked in 100-pound sacks designating them "ground sunflower seed hulls" and tagged them minimum protein 4 percent, guaranteed fat not less than 2.00 percent, and maximum fiber 50 percent. As I did not desire to take ny chances, with no more analytical work than we had, I naturally tagged the hulls low in product values. Actually our hulls ran between 6- and 8-percent protein, 3-1/2- to 5-percent fat, and maximum fiber of some 44 to 45 percent.

As you know, I have given much thought and time, as well as my company's money, in an attempt to introduce this crop in our section, namely, Alabama. I feel that this crop is going to succeed and its success depends upon the amount of energies and enthusiasm that we in this industry will put forth in its development in all stages.

We have made a market for sunflower seed and, at this time, I think that we shall offer $70.00 per ton which is a $10.00 increase over last year--this at a time when in all probability soybeans will see a decline. The prospects for this crop is excellent--time, of course, will tell.

Some of you present may not feel that we have a need for an additional crushing seed as you have been currently running your plants 9, 10, and 12 months. This may not continue to be so with the future facing cotton; therefore, you should be interested in any additional profitable crushing oil seed. Most of us, as you well know, in the Southeast have not had a sufficient crush and are badly in need of a second or even a third supplemental crop so that we might have an opportunity to operate our plants with more tonnage on a profitable basis.

PROCESSING OF SUNFLOWER SEED BY SOLVENT EXTRACTION

by

G. J. Grady
Sun Plant Products, Inc.
Gonvick, Minn.

(No copy of this paper available for publication.)

FEEDING VALUE OF SUNFLOWER MEAL

by

K. J. Smith
National Cottonseed Products Association, Inc.
Memphis, Tenn.

Several experiments have been conducted on the nutritional value of sunflower meal in the rations of poultry, swine, and ruminants. This presentation will examine the nutritional value of sunflower meal and its use applications in livestock and poultry rations. This review is based on a published paper appearing in **Feedstuffs**, a weekly publication of the feed trade.[1]

The nutritional significance of sunflower meal as an alternative protein ingredient for the feed manufacturer or livestock producer will depend on several related factors. With today's emphasis on the use of computers to formulate rations, it is essential for sunflower meal to be competitive with other oilseed protein sources if widespread utilization is to occur. The computer's evaluation of a protein source, and the resulting value of the product in ration formulations, will depend on several factors. Such factors as the nutrient composition of the protein source, the presence of toxins or anti-nutritional factors which would set upper limits on the amount which may be included in a ration formulation, the complementary effects of other ingredients in the ration, and the nutrient specifications of the particular ration being formulated are some of the factors which determine the value of a protein supplement, such as sunflower meal, in a particular ration formulation.

Since no nutritional toxins have been reported present in sunflower meal, and since we must assume that market value of a protein source will be set by its nutrient composition in relationship to alternative protein sources, it is readily apparent that the value of sunflower meal for a particular end use is largely determined by the composition characteristics of the meal.

The composition of the sunflower meal may be varied according to the composition of the seed being crushed and according to the method of processing. The most marked improvement in sunflower meal production has been the recent lowering of the crude fiber content by hull removal during processing.

The Northern Regional Research Laboratory, ARS, USDA, recently published information on the composition of different sunflower seed varieties.[2] Of particular interest was the hull fraction of the seed. The hull accounts for 22 to 28 percent of the weight of the sunflower seed. The relative percentage does not vary with oil or protein content but is related directly to the weight of the seed. The larger seed have a greater proportion of hull.

The hull plays a major role in determining the value of the sunflower meal, since the amount of hull or fiber present in the meal definitely limits the usefulness of the meal. Nonruminants cannot utilize high fiber meals efficiently. In the nonruminant ration there is current emphasis towards high-energy rations which will produce rapid and efficient gains. Therefore, use of the high fiber sunflower meals will find primary use as protein supplements in cattle and sheep rations. Oil mill processing procedures can control the crude fiber content of the meal by adjusting the proportion of hull that is removed before extraction or by the extent of tail-end meal screening. While nutritionally, meals of high protein,

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[1] Smith, Keith J. 1968. A review of the nutritional value of sunflower meal. Feedstuffs 40 (23): 20.

[2] Earle, F. R.,VanEtten, C. H., Clark, T. F., and Wolff, I. A. 1968. Compositional data on sunflower seed. Jour. Amer. Oil Chem. Soc. 45: 876-879.

low fiber are desirable, the actual economics of markets for both meal and hulls must be considered in determining the amount of hulls to be removed.

The relationship of hulls to energy content of chick rations was demonstrated in metabolizable energy studies conducted by Lautner and Zenisek.[3] Gross energy values of 2190 and 2210 Kcal/lb and metabolizable energy values of 870 and 1180 Kcal/lb were reported for whole sunflower meal and soybean, respectively. These results indicate that gross energies are similar between the two protein sources. The metabolizable energy, or the energy available to the animal, is approximately 27 percent less for the high fiber sunflower meal as compared with the soybean meal. This difference is due to the amount and utilization of the hull part of the meal.

Studies have been conducted relating the effects of excessive processing temperatures to the nutritive value of sunflower meal. In general, like other oilseed proteins, the nutritive value of sunflower meal is greatly affected by conditions employed during processing. The milder heat-treated meals have had higher digestibilities, supported greater gains, and lower feed units required per unit gain. High temperatures in conditioning the meats, or in extracting, will severely damage the protein and decrease its nutritional value to the animal. Bandemer and Evans,[4] reported that heating sunflower seed to 250° F. for 45 minutes caused small losses in most of the amino acids, with the largest decrease in the basic amino acids–lysine, histidine, and arginine. These three amino acids are initially marginal in sunflower meal.

The amino acid composition of sunflower meal has been thoroughly investigated and lysine has been found to be the first limiting amino acid. Several researchers have reported experiments showing that additional lysine will improve performance of rations when sunflower meal is the principal protein source.

It has been suggested that the sulfur amino acids are deficient according to the amino acid analysis of sunflower meal. Growth experiments with methionine-supplemented-sunflower meal have failed to support this conclusion. Therefore, it may be that the sulfur amino acids are only limiting when lysine is adequate.

Other possible limiting amino acids have been investigated using semi-purified diets, with sunflower meal as the sole source of protein. These include glycine, arginine, phenylalanine, histidine, leucine, and tryptophan. These experiments have not shown beneficial responses from added levels of the above amino acids.

Over the years there have been several reports published on experiments comparing the nutritional value of sunflower meals to other commonly used protein supplements. Even though the results of these experiments are often confounded and confused by many factors which tend to dilute the results, general observations may be made on the comparative utilization of sunflower meal by the different species of animals.

Various researchers have reported experiments utilizing sunflower meal in poultry rations. In general, it has been concluded that sunflower meal may be used in poultry rations provided care is taken in formulation of the ration to insure that the requirement of the amino acid lysine is met. Since lysine is normally low in sunflower meals, it is impossible to directly substitute sunflower meal for another protein source unless other adjustments are made in the ration, such as lysine supplementation or increasing feed ingredients normally high in lysine content. Since most of the reported research has been done with high fiber meals, there is a need for studies to demonstrate what may be done with the low fiber meals which may now be produced. Some initial research is being sponsored by the Association to determine the value of low fiber sunflower meal in poultry rations. The results of these studies should be available in the near future.

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[3] Lautner, V., and Zenisek, Z. 1964. Estimation of the energy value of components of feed mixtures for chickens. Zivoc. Vyr. 9: 561. (Abstract in Nutrition Abstrs. and Reviews, 1965. 35: 540.)

[4] Bandemer, Selma L., and Evans, Robert John, 1963. The amino composition of some seeds, Jour. Agr. Food Chem. 11: 134-137.

The first swine work using sunflower meal was published in 1921 and reported that sunflower meal compared favorably with tankage as a protein supplement for fattening hogs weighing over 100 pounds. These results are definitely dated; however, there is considerable foreign swine research which has recently been reported. This research has been stimulated with the interest to determine the replacement value of sunflower meal for imported soybean meal. The results generally indicate that some sunflower meal may be used in swine rations; however, complete replacement of the soybean meal with sunflower meal will result in lower daily gains and high feed conversion ratios. It has been suggested that part of the difference in performance between soybean meal and sunflower may be due to palatability of the protein source.

Dr. Cunha, Florida State University, in reviewing the use of sunflower meal for swine, suggested that sunflower meal could be used as 20 to 30 percent of the protein supplement for growing-fattening pigs and that it should be fed, preferably, to animals after they have reached 75 to 100 pounds body weight.

Surprisingly little research has been reported on the utilization of sunflower meal for ruminants, even though sunflower meal is used in fairly large amounts as a ruminant protein supplement in certain foreign countries.

The University of Florida in 1954 reported results of two steer experiments in which cottonseed meal and sunflower meal were compared as supplemental protein sources. There were no differences in rate of daily gain, feed required per unit gain, dressing percentage, or carcass grade between the two protein sources. The authors did state that cottonseed meal was more palatable.

These results are not surprising since one can cite numerous references in the literature which would indicate that natural protein sources are utilized in the rumen similarly. Therefore, one would expect similar performances.

It was shown that sunflower meal and urea were equal in their ability to supplement nitrogen to a corn silage ration for sheep. Nitrogen retention was similar between the two nitrogen sources.

High levels of sunflower protein were fed to dairy cows and the quality of the milk produced was then studied. The results indicated that supplementing the basal ration with 6.6 or 11.0 pounds of sunflower meal daily had no adverse effects on milk yields, butterfat percentage or composition, and quality of whole dried milk – fresh or after 2 years' storage.

In summary, properly processed sunflower meal is a high quality protein source for inclusion in livestock rations. In practical swine and poultry rations, which are nutritionally balanced for all needed nutrients, a high protein, low fiber sunflower meal should be equal in value to other oilseed protein supplements in supplying a portion of the needed supplemental protein.

In ruminant rations, sunflower meal is fully equal to other oilseed proteins in supplying a needed nitrogen source for the synthesis of bacterial protein in the rumen.

SUNFLOWER OIL AS A SALAD AND COOKING OIL

by

H. J. Hlavacek
Hunt-Wesson Foods, Inc.
Fullerton, Calif.

It's certainly a pleasure to be with you this afternoon and to share some of our observations on sunflower oil. I will review a limited selection of the information available in the scientific and agricultural literature which is pertinent to our subject. In addition, I will cover our own laboratory observations, some of which may be new to you or at the very least will amplify or support current literature observations.

As one of the largest producers of salad oil, we have a continuing interest in alternate raw materials which may have utility in our business. With the production during 1967 of over 20,000,000 pounds of domestically produced sunflower oil, this oil for the first time became available in the kind of quantities which start to interest the large producers. Although this was only a small amount with respect to our oil needs and not the kind of quantities which would justify changes, it does suggest that this could be the beginning of an extensive domestic business.

In the past, sunflower seed has been a limited production crop in the United States. The major production areas (14) have been the U.S.S.R., followed by the Eastern European countries, and then South America, primarily Argentina. Worldwide production (18, pp.19-20) of the oil since 1961 is summarized in table 1.

Table 1. – World oil production

Year	1,000 tons		
	Sunflower oil	Cottonseed oil	Soybean oil
1968[1]	3,785	2,565	5,400
1967	3,440	2,450	5,280
1966	2,990	2,715	5,010
1965	3,035	2,750	4,585
1964	2,330	2,685	4,360
1963	2,565	2,595	4,290
1962	2,185	2,490	4,115
1961	1,990	2,340	3,750

[1] Forecast.

Source: U.S. Foreign Agricultural Service (18, pp. 19-20).

Since 1961, sunflower oil has almost doubled in production, while soybean oil has increased by about 50 percent, and cottonseed oil by about 10 percent. In so doing, sunflower oil production has moved from fourth position to second position. Oil exports have paralleled this change in position. This increase in production of sunflower oil is at least partly responsible for the recent price history [1] on sunflower oil (table 2).

Table 2. – Sunflower oil prices – Rotterdam market.

Month	Dollars/hundred weight			
	1969	1968	1967	1966
January	8.39	8.33	10.34	12.20
February	–	8.14	9.92	12.47
March	–	7.64	9.99	12.13
April	–	7.13	9.53	12.01
May	–	7.26	9.48	11.86
June	–	7.34	10.47	11.72
July	–	6.87	9.87	11.97
August	–	7.10	9.77	12.18
September	–	7.97	9.40	12.02
October	–	7.73	9.13	11.27
November	–	8.13	8.90	10.80
December	–	8.52	8.64	10.70
Monthly Average	–	7.68	9.62	11.83

[1] Huss,.E. G. (Hunt-Wesson Foods), Private communication.

It has been suggested [2] that an even greater stimulus in the price decline of sunflower oil has been the entry into the European markets of oil from the U.S.S.R. In 1966, world exports of sunflower oil (18) increased by 80 percent following with a further 40 percent increase in 1967.

In the last few years, the production of sunflower seed in the United States has not been static. Between 1963 and 1967, the Red River Valley areas of Minnesota and North Dakota have seen a fourfold increase in seed production. The latest figures indicate that this is split about equally between varieties for oil and other uses, primarily bird seed (14). This increase in plantings and present emphasis on oil varieties appears to be in large measure due to the introduction of varieties developed in the U.S.S.R. which give sunflower a better opportunity to compete against domestic crops. It would appear that further domestic expansion can be expected as improvements are made in the oil yield and disease resistance of existing varieties (8).

The older literature (12) indicates that European processing involved cold pressing of the seed followed by a hot pressing. Undoubtedly, some of this has by now been converted to solvent. The cold-pressed oil is usually pale yellow with a mild and pleasant flavor while the hot-pressed oil is a reddish yellow and usually utilized in inedible products including protective finishes. The introduction of modern processing methods has permitted the use of hot-pressed oil for edible use.

Sunflower oil has been "much esteemed" as a salad and cooking oil in Europe (12). In addition, it has found extensive use in shortening and margarine. It is reported (3) to be the principal raw material used for the manufacture of margarine in the U.S.S.R.

From its reported fatty acid composition, one would expect excellent performance as a domestic salad and cooking oil. Although there are numerous reports in the literature of the high esteem in which the oil is held for this particular purpose, there is little reported with respect to performance of the oil as measured by domestic standards for the retail market. With this in mind, we undertook a limited study designed to give us information on the chemical, physical, and organoleptic characteristics of sunflower oil. With the help of the National Cottonseed Products Association and our own Vegetable Oil Buying Department, samples of oil or seed or both were solicited from readily available sources during 1968. These samples represent the extremes ranging from trial plots of specific sunflower seed varieties to the commercial production of oil from seeds of mixed varieties. Samples of seed were crushed and then solvent extracted with hexane. Oils not intended for conversion to finished product were analyzed either as crude or refined, depending on their state as received. Oil to be evaluated as an edible product was given normal laboratory processing including: (a) batch (kettle) refining followed by centrifugal separation of soapstock, (b) vacuum bleaching with 1.0 percent B. C. earth at 115° C. for 30 minutes, (c) deodorization for 1 hour at 235° under 4- to 6-mm. pressure and (d) addition of 33 p.p.m. citric in the form of a 10-percent aqueous solution during the cooling cycle following deodorization. The oil used for product evaluation had come from seed grown in the Red River Valley area of Minnesota and North Dakota. This oil represented a full-scale commercial operation in which the seed was solvent-extracted and the resulting oil degummed. As received, it had a free fatty acid of 0.4 percent compared with samples from other areas which were as high as 2.0 percent. It had an initial Lovibond color of approximately 4.0 Red and processed easily into a bland oil with a Lovibond color of 0.4 Red.

For determination of fatty acid composition, methyl esters were prepared via the method of Metcalfe (15). Quantitation of fatty esters was carried out with an F & M Model 700 gas chromatograph equipped with hydrogen flame detector and an 8' x 1/4" (OD) column packed with 20 percent DEGS on 60/80 mesh Chromosorb W. Fatty acid composition and information on growing areas and seed varieties are summarized in table 3.

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[2] Kuang, H. H. S. (Hunt-Wesson Foods), Private communication.

Table 3. – Sunflower characteristics.

Growing area	Growing period	Variety	Fatty acid composition			
			IV	C18-1	C18-2	All others
Texas	3/68-7/68	Peredovik	103	53.5	35.1	11.4
Do	4/68-7/68	Mostly Peredovik some Armavirec	114	45.7	43.6	11.7
Do	4/68-7/68	Peredovik	115	44.6	41.6	13.8
Do	4/68-7/68	Do	116	45.6	41.4	12.7
South Carolina	4/68-7/68	Peredovik and Armavirec	116	42.6	45.1	12.3
Texas	5/68-9/68	Peredovik	[1] 118	37.5	49.3	13.2
California	1968	Mixed	123	28.3	57.6	13.1
Alabama	1968	Peredovik	127	28.7	57.6	13.7
Canada[2]	?	?	130	24.1	64.1	11.8
California	Late 1968	Peredovik	136	16.2	69.4	13.4
Minn. & North Dakota (Red River Valley)	Summer 1967	Peredovik and Armavirec	138	18.4	68.7	12.9

[1] Calculated from fatty acid composition.
[2] Commercial salad oil.

Although Hilditch and Williams (11) observed even greater variability in oleic acid (maximum 71.8 percent) and linoleic acid (maximum 76.8) on a worldwide basis, it is suprising to see such a large spread on such a limited domestic sample. These data certainly confirm previous reports (11, 13) that the degree of unsaturation is largely dependent upon the climatic conditions during the growing season. The seed which produced the lowest iodine value oil was grown in central Texas where high head during the specified growing period was likely. A recent sampling (6) of six sunflower seed varieties grown in Canada and the Northern United States confirmed the relative uniformity of fatty acid composition under comparable climatic conditions, regardless of variety. Sunflower oil has been classified (11) as both a drying and a semidrying oil. This is undoubtedly the result of the variability in unsaturation. Since temperature influences only the oleic and linoleic acids, "all other" fatty acids as a group are relatively constant

and have been so summarized. The bulk of the "all other" category is composed of 5- to 8-percent palmitic acid, 4- to 7-percent stearic acid, and one-half- to 1-1/2-percent behenic acid. Trace amounts of fatty acids identified as myristic, linolenic, and arachidic acids were also found. Linolenic acid has previously been reported by others (4) in a broad sampling of non-domestic sunflower seeds. In our particular samples, oils extracted directly from the seed in an unambiguous laboratory or pilot plant operation showed at most a trace of linolenic acid. Seed processed commercially showed up to 0.5 percent linolenic acid, suggesting the possibility of contamination with soybean oil.

Increasingly, manufacturers and regulatory groups are paying close attention to the maintenance of integrity of raw materials. Accurate label declaration and good manufacturing practices are both stimuli. Failure to do so can cause major difficulties, particularly for one engaged in the manufacture of shortenings or margarine oils. With the current extreme of unsaturation possible with sunflower oil, it will be difficult for a manufacturer to easily monitor his raw material without resorting to a determination of fatty acid composition. It would seem highly desirable for this new industry to concentrate efforts on growing conditions which minimize this effect. As an individual, I favor the more highly unsaturated oil produced from seed grown in Minnesota, North Dakota, and parts of California. The reasonably high unsaturation achieved in one single sample of seed grown in Alabama suggests that this might be achieved in the South, perhaps through a fall planting.

With the Minnesota oil, chemical measurers of oxidative stability including the AOM (2) or the oxygen bomb (17) were not appreciably different than would be expected for unstabilized cottonseed salad oil. AOM values of 9 to 10 hours and oxygen bomb values of 3 to 4 hours were obtained.

Physical characterization of the Minnesota sunflower oil yielded some points of difference compared with many commercial salad and cooking oil products. Although the actual value to the consumer may be questionable, most retail salad oils will provide a cold test (1) of 20 hours or more. The high iodine value sunflower oil, on the other hand, may show a distinct haze which one must call the endpoint in as little as 4 hours. This parallels our observations with safflower oil. Depositions of visible fat crystals may not take place for an additional 30 hours. We have assumed that the preliminary hazing, which does not impair the ultimate cold test, is due to wax esters, previously reported (5) as mainly ceryl cerotate. Most recent literature (10) suggests that these esters are composed of mono-carboxylic acids from C_{14} to C_{30} and mono-hydroxyl alcohols from C_{14} to C_{32}. We have not attempted separation or isolation of these materials because a noticeable influence on salad oil quality was not expected. The lower iodine value sunflower oil might be expected to have a considerably shorter cold test. This could not be tested because of sample limitations.

In the laboratory with a limited number of different lots of oil available, it has been easily possible to achieve a deodorized package product with a Lovibond color as light as 0.4 Red. Colors this light or even lighter may be achieved in a factory operation. This expectation is easily confirmed in data supplied by the Corn Products Company [3] where the color of refined and bleached Minnesota sunflower oil ranged from 0.8 to 1.2 Red. Further color reduction during deodorization would easily reduce the color to 0.5 Red or less. It has been observed (7) that oils as light as 0.1 Red can be obtained in normal commercial processing. Chlorophyll levels have not been high, and green casts have been absent from the finished product. Packaged in flint glass, this product may look almost "water-white," and we have some concern about consumer reaction. This characteristic could obviously be largely overcome by packaging in amber glass or adding an appropriate food coloring. Because of sunflower oil's good stability, there is little need for amber glass other than to mask color. This assumes that the oil will be handled and packaged under conditions yielding low levels of dissolved and headspace oxygen.

Sensory evaluation was limited to the most unsaturated oil available, namely that from Minnesota.

[3] List, R. W. (Corn Products Company), Private Communication.

Sunflower oil of lesser unsaturation could be expected to perform at least as well, though better oxidative stability as a consequence of reduced unsaturation would probably be difficult to demonstrate.

In our laboratory, the following procedure is used in the evaluation of a salad oil:

1. After cooling in the deodorizer, oil is filled into flint glass bottles with minimum inclusion of oxygen. Before capping, the oxygen level of the headspace is reduced to less than 1 percent by sweeping with nitrogen (9).
2. Oil is evaluated by an expert oil panel initially and after stress of the kind observed in the normal distribution pattern including home use.
3. Stressed oils are evaluated in the preparation of bland, flavor-sensitive food products. This may include eggs, French fries, or salad, or possibly all three, depending on the use for which the oil is intended.

Stress applied to the oil has been planned to imitate and **reasonably accelerate** the kind of normal abuse to which the product is exposed in the course of being consumed. This includes light exposure of the unopened bottle to duplicate store abuse and subsequent dark storage of a partly empty bottle to duplicate home abuse.

Trained panelists evaluated the oil on a 1-to 10-flavor intensity scale where 10 equals none and 1 equals extreme. Panel results are evaluated statistically and past data have shown that means must differ by 0.5-to 1.0-scale unit to achieve significance at the 0.95 level. Results on Minnesota sunflower oil compared with one set of results on cottonseed salad oil are summarized in table 4.

Table 4. – Flavor.

Oil	Initial	After light exposure	Half full bottle
Sunflower oil	7.75	7.25	6.00
Cottonseed salad oil	8.18	8.00	7.00
Sunflower oil[1]	7.67	–	–
Sunflower oil[2]	7.50	–	–

[1] Crude oil bleached and deodorized only.
[2] Crude oil deodorized only.

Although these data numerically favor the performance of cottonseed oil, much previous experience would lead us to conclude that these figures are probably not different and that sunflower oil does perform well as a salad and cooking oil. Evaluation of French fries prepared in sunflower oil indicated no difference when compared to those prepared in Wesson oil. Because this Minnesota crude oil was extremely lightcoloted, we explored the effect of progressively deleting refining and bleaching steps on the initial flavor of the oil. These results are summarized on the last two lines of table 4. This reduced processing might adversely influence oxidative stability which was not characterized. Colors of the deodorized samples were comparable to that obtained on oil that was refined, bleached, and deodorized.

Oxygenated acids, including epoxy and hydroxy acids **(16)** have been identified in sunflower oil. Although it has been observed **(7)** that the role of these components on oil quality has yet to be determined, we have inferred from our data that they are not a cause of flavor instability.

The excellence of sunflower oil has been recognized outside Europe. Within the last few months, Canada Packers introduced sunflower oil under their "Domestic" label. Their packages are fabricated of amber PVC or tinted polyethylene. Our evaluation would indicate the oil to be of good quality despite the presence of an air headspace and a package which, unlike glass containers, is permeable to oxygen. The gallon container was damaged at the left corners. Although it could not be established whether this was due to handling or container collapse, further distortion occured during storage as oxygen was absorbed by the oil. We have previously observed distortion of this type in semi-rigid containers, particuarly if no attempt has been made to gas-package the oil.

In summary, our evaluation indicates that the most highly unsaturated domestic sunflower oil available to date provides excellent performance as a consumer salad and cooking oil. From a manufacturer's standpoint, a narrower range of unsaturation would be highly desirable to simplify plant operations including raw material monitoring and storage.

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PRODUCTION POTENTIAL BASED ON INVESTIGATIONS

by

M.L. Kinman
Agricultural Experiment Station
Texas A&M University
College Station, Tex.

I came here today for one primary reason and that is to point out that after all of the nice things that have been said about sunflowers--and I will go along with everything that has been said today--there is still some question of whether sunflowers as a crop can make it in stiff competition with other crops, especially other oilseeds in the United States and in southern agriculture.

Now, the present varieties available--the high oil commercial varieties introduced from the USSR--may serve as a stopgap for a time and allow expansion of production of oilseed sunflowers. I don't want anyone else held for this so I will give it as a personal opinion and I want you all to accept it as such. I do not believe that these high oil varieties are good enough for a permanent place in American agriculture. If I didn't have some alternative to this, I wouldn't dare say it.

There is an alternative and the following data show it. Comparison of a disease resistant F_1 sunflower hybrid with the best high oil Russian variety grown in yield tests in the Cotton Belt in 1968:

	Number of test averaged	Peredovik	P-21 ms X HA 60
Height, in.	3	82	85
Date of 50 percent bloom	4	6/6	6/7
Days from 1st to 95 percent bloom	2	18	8
Seed yield, Lb./A.	8	1020	1449[1]
Oil content of seed, percent	2	39.4	39.7
Oil yield, lb./A.	2	434	690[2]

[1] 42-percent increase
[2] 59-percent increase

Location	Seed yield, pounds per acre: Peredovik mean	P-21 mx X HA 60 mean
Cantau, Calif.	1,440	1,529
Experiment, Ga.	1,022	1,388
Stillwater, Okla.	642	1,420
Clemson, S. C.	1,148	1,505
College Station, Tex.	964	1,694
College Station, (Test No. 2), Tex.	1,244	1,775
McGregor, Tex.	533	622
Thrall, Tex.	1,168	1,656

This is very incomplete data. We have here the variety Peredovik compared in various ways with the first of the high oilseed sunflower hybrids that is possible from inbred lines developed and released by the cooperative USDA-State Agricultural Experiment Station Breeding Program. Availability of these hybrids are not 3 to 5 years from now, but the seed stocks are available now. When I say seed stocks, I mean only the parental lines. The hybrids had to be made and it hasn't been thoroughly demonstrated yet that they can be produced economically commercially. These hybrids were produced under experimental conditions and we have not determined, nor will we ever be able to determine in a research program that they can be produced economically enough in commercial seed production. This will be up to the seed producing industry to tell us.

If this doesn't work then we have other alternatives. P-21 ms is the female parent of this hybrid and is a genetic male sterile. The best that we are able to do is to obtain 50 percent of the plants which are the male sterile and shed no pollen. This means that the other half must be removed from the crossing field and pollen from the male parent only allowed to fertilize the male sterile plants to give you the hybrid seeds from which the production crop ought to be grown.

Now, we generally recognize Peredovik as either the best or one of the best of the Russian varieties. As you can see, the Peredovik and the hybrid are similar in height in the three tests in which they were compared for this characteristic. They are also almost identical in 50-percent bloom date so that there is not very much difference either in time of flowering or maturity.

There is the next characteristic--days from first to 95-percent blooming period--and is much greater in the open-pollinated variety than it is in the hybrid.

Dalton Gandy showed us an illustration of the uniformity of hybrids very nicely. We know that this shortened flowering period will be of great asset in the control of insects--particularly the sunflower moth that can be so destructive--and more economical by saving one, two and possibly three applications of insecticides.

Now we go to the eight tests and compare yields. These yields are not really high when we get all of the eight tests involved and averaged. We do have a 42-percent increase or over 400 pounds per acre increase for the hybrid over the best of the other varieties.

The 1968 data are not all in. Some of the cooperators who participate in the United States Regional Sunflower Testing Program haven't seen fit to send in their data yet, so we have here data only from California, Georgia, Oklahoma, South Carolina, two tests of College Station, Tex., one at McGregor, Tex., and one at Thrall, Tex.

Yields of the hybrid were high in all locations. Yield difference was greater in some tests than in others and yields for the open-pollinated variety ranged from 533 pounds at McGregor, where the test was pretty poor, to 1,440 pounds in the California test at Fresno, Calif. Under these same conditions we had yields running up to 1,775 pounds for the hybrid and down as low as 622.

Now I am showing am showing data only from the Cotton Belt here. If we showed data from the Northern locations there would be included a difference in oil content in favor of the variety Peredovik. In the Red River Valleys of the North this hybrid produces about 42 percent oil where Peredovik is producing 45, 46, and 47 percent. This does not appear to be so in analyses that we have had from Southern tests where we have similar oil content of the hybrid and the open-pollinated varieties. There happened to be only two tests involved at College Station, Tex., where the yields per acre were quite different, too. We had a 59-percent increase in oil yield per acre in these two tests.

In a number of locations and in a number of growing conditions, it is fairly easy to demonstrate experimentally in this fashion that properly constituted F_1 hybrids can be expected to outyield the Russian varieties significantly. The hybrids can have some other advantages in uniformity, insect control, and perhaps--although we have less evidence of this--more uniformity in maturity and, therefore, easier harvesting and less harvest loss. This indication remains to be proved because I don't think we have any real proof in that regard.

Now, this is with the first high-oil hybrids developed in the United States. It does happen to be resistant to all of the North American nations of rust, which is the most universally hazardous disease of sunflowers. Certain sublines of the P-21 ms female

parent are also virtually immune to Verticillium wilt. The hybrid between the female parent of the hybrid is highly resistant to Verticillium wilt and the male hybrid highly resistant to both diseases. This has been demonstrated without any question.

Under this year's testing conditions there really wasn't much effect from any disease in these tests. One of the College Station tests did have an effect from rust. In most of the others, these were just simply differences in yield because of the local environmental conditions. We think that probably 25 percent of that 40-some percent increase results from hybrid vigor and the other from resistance to disease and insects. The hybrid also has some resistance to the larvae of the sunflower moth.

You see, I wouldn't have condemned the Russian varieties so heartily if I didn't have some indication that this could be improved, because, obviously, I would be out of a job and maybe we would be out of a crop if this were the case. But, we do have definite evidence that they can be improved upon. That just happens to be the first high-oil hybrid that has ever been developed in the United States--even experimentally. There have been a few instances in the past when the first set of hybrids that came out were also the best. I don't think that that is the case here.

In one test where we compared some 70 different hybrids--using different sublines of P-21 ms as a female parent and a wide section of male parents most of which were rust resistant and many of which carried a good deal of resistance to insects--over half of the hybrids tested gave oil yields per acre of at least 20 percent higher than the variety Peredovik. Fourteen of these hybrids gave higher oil yield than did the hybrid on which I showed you the data today.

Part of this increase in oil yield per acre was due to the fact that some of the hybrids yielded grossly higher than did Peredovik or the standard hybrid. Yields in this particular test, for instance, in Peredovik were 1,244 pounds per acre, and of the hybrid that I showed you in that test--in this particular test, it gave a yield of 1,775 pounds per acre. Certain of the highest yielding of the other new hybrids gave yields of about 2,100 pounds per acre. In this particular test Peredovik had a 40-percent oil content and the hybrid had 42.5. I do not consider those to be significantly different. Under Southern conditions we do not traditionally or by experience expect as high an oil content of the seeds as those seeds grown in the Northern area. Ordinarily this difference is in the realm of 4 to 8 percent in favor of Northern-grown seed. This is in addition to the differences in linoleic acid content of the oil. In this test Peredovik had 40 to 42.5 percent oil, but we had some new experimental hybrids that ran up to 49.7 percent oil. This indicates that it is possible with the right hybrid combination to produce as high oil content in Southern-grown sunflower seeds as it is with the present Russian varieties even in the Northern States.

Now these same varieties, these same hybrids, or most of them, were also tested in the Red River Valleys up north. Later in the season we will see whether they perform similarly with regard to oil content. If they did, there are some of them that will go well into the 55-percent figure. This research program has really had financial support--only modest support at that--for the past three seasons. The Russians took about 30 years or so to produce these high oil varieties. We can use speed-up methods in developing hybrids, building on this material and incorporating at the same time disease and some insect resistance, higher yields, more uniformity, and even higher oil content. We have no indications as to the chemical differences in compositions of oils.

All we have to do is get some of these hybrids into production and we will be in a better position.

I don't want to overlook the fact that good cultural practices can increase yields of sunflowers. Mr. Gandy reported yields approaching a ton or even some over 3,000 pounds and at an estimated 35-50-percent field loss. This indicates that even with the present material we have a potential of producing, occasionally, at least, yields of two tons per per acre under favorable conditions. I think that we can increase the probability of such yields by the use of hybrids. We can produce such yields more often and bring the average up.

DISCUSSION OF REPORTS

QUESTION: I would like to ask Mr. Kidd what moisture level he goes through the screw press?

MR. KIDD: Actually, we had such variable

conditions--we normally go to the screw presses on the cottonseed. If you will let me vary here a moment to the cottonseed, at approximately 3 percent moisture at the down-spout. The sunflower meats at the downthrust are in the range of 4.5. We would have liked to have gotten a little lower but for some reason with the type of seed available we had problems drying them out.

QUESTION: Mr. Kidd, in your talk you indicated that you recommend higher cooker temperatures than you actually used yourself. I think you recommended 265° to 275°, is that correct?

MR. KIDD: That is correct.

QUESTION: This little NCPA pamphlet indicates that minimum heat during processing insures the quality of the meal. How do you reconcile these two standards?

MR. KIDD: I shouldn't make an attempt to reconcile this. I will agree with them that heat does damage the protein. However, I have always had an argument with nearly everyone else in the industry that it is the amount of heat and the time when the heat is applied that is one of the major factors. I did say that with these temperatures, providing they were not held at this point for too long, I don't believe you would get too much damage because we don't get these temperatures except out of the bottom or last cooking kettle.

The temperatures are actually coming from the top to bottom in the six rings in the neighborhood of 160° to 165° at the top ring; the second ring at approximately 210° to 215°; at the third ring we're about 225°; about 225° in the fourth. We do get up to around 240° to 250° in the fifth ring and we hit the top temperatures only in the bottom kettle where you only have 6, 7, or 8 minutes.

QUESTION: What is your total cooking time?

MR. KIDD: On the average, the total cooking time that we think would be the best with the type of seed available is approximately 45 to 50 minutes.

QUESTION: Mr. Hlavacek, you mentioned something about gum in your talk. Is there a gum problem?

MR. HLAVACEK: No, I think what I said was that we have received oil that was alkali-refined and degummed before our receipt of the oil. This is the way the processor had handled it. I think this was processed by Cargill.

QUESTION: Dr. Kinman, you stated that you didn't believe that the present varieties would prove competitive in U.S. agriculture. Did you refer to the return per acre to the grower?

DR. KINMAN: Well, if we can't have a cent or so higher price for the seed--a cent or so per pound--we had better have another 10-to-15- to 25-percent increase in yield to make it very attractive to growers. There is some resistance on the part of growers to the price at the present time for the yield of the varieties that are available for them to grow.

This is particularly true in the Northern area where, actually, from a good start in 1967 the increase of oilseed sunflowers instead of doubling, halved. This is when the world price for oilseed caused the value of the product to be reduced. This was caused a good deal because of the dumping of sunflower oil on the world market as the Russians did and it kind of hurt us in all of our oilseed prices. Of course, now if we were doing it, it would be good business. When they are doing it, it is dumping, you understand.

COMMENT: For a company that is interested in developing a proprietary source of oil alone and wasn't too interested in the meal aspect, sunflowers offer great promise--in other words, they don't particularly care for the meal.

DR. KINMAN: That is right. You will have to be able to get rid of the meal somehow though, because there will be some with any product.

COMMENT (MR. KIDD): May I supplement what has just been said in the way of a little bit of information? This is only Jack Kidd's opinion and does not apply to a pre-pressed solvent but to a screw press or straight mechanical operation of that nature, Anderson included. The tonnage, I believe, through the press room would be the equivalent of whatever your cottonseed tonnage under the normal average operating condition of the mill. This was not true in my case, I don't operate like the other mills as we run a pure meal operation on cottonseed. This is at 230 tons a day. We feel that we could if we could get the meats from the front end of the mill in sufficient quantities, we feel that we could do 190, possibly 190 tons of sunflowers, which is the equivalent of what we do 230 tons of cottonseed on. However, I think that any mill that has been operating with 41-to 42-percent protein through the press room would be

able to crush as many or more tons of sunflower seeds per 24 hours with this equipment.

QUESTION: Mr. Kidd, do you run into any problems getting rid of the excess oil? What I am trying to get at is, don't you have a bigger flow of oil from the sunflower than you would from cottonseed?

MR. KIDD: Yes, but I don't think that this presents any problem with a screw press and an expeller operation. You open your screen bars wide enough to permit the flow of oil easily and it is no problem. You have been working peanuts for some years at the 45-to 55-percent fat content on the same equipment and there is no problem with expelling the oil from the cake throughout the press.

QUESTION: I don't think I made my question clear. I was just thinking about the physical getting rid of the oil that you have. Wouldn't you have a higher flow of oil--more gallons from it on the same screw press?

MR. KIDD: Yes, definitely so. There is no problem there though as the oil just flows right on down through, and we could handle four times that volumn through the same equipment. There is no problem in handling the flow of oil.

QUESTION: Is the nature of the hulls on the various different high-yielding hybrids about the same, or is there a difference in the variation of how these hulls are removed?

DR. KINMAN: Given the same oil content you can expect about the same thickness and tightness of hull. There is, however, in Northern areas some processors quite concerned to keep the black color of the Russian varieties in any hybrids that come out, or any new varieties. This is because they are confronted with the possibility that if the price of oilseed sunflowers should be higher than birdseed, then they would get a lot of birdseed dumped in on them, which would be low in oil. Presently the birdseed types are all striped. Now some of these hybrids are also striped and they are a different color, a different looking seed. But, as far as the decortication process is concerned, I have no reason to believe that with a similar oil content you would run into any differences in hulling.

SUMMARY

by
N. P. Bartmess
Kennett Oil Mill, Inc.
Kennett, Mo.

During the opening session of this Conference we were given a report on the outlook for cotton and the prospects for the immediate future are much brighter than the dark and dismal days we have experienced in the years just passed. However, the long-range outlook for cotton remains a cloudy picture. As we all know, cottonseed is actually a byproduct of cotton and we in the cottonseed processing industry must live or die with the ups and downs of cotton production. With this in mind and digesting the papers presented here these 2 days, we do look forward to the immediate future because:

1. Cotton must be grown to meet the demands for a constant and adequate supply of the fiber.
2. Continued processing research and resulting improvements is leading to a wider utilization of our products.
3. The potential of the glandless cottonseed and its yielding high grade oils, meals, and flours could result in uses in many food formulas.
4. With the aid of research we are gaining knowledge to improve our storage and processing of cottonseed with the end result that we will produce a superior-grade protein for many uses worldwide.
5. Food & Drug is seeing that we keep our plants clean and respectable and thus make our end products readily acceptable.
6. The development of the flame-retardant cotton batting products and its potential markets.
7. The possibility of blending the processing of the sunflower seed with the processing of cottonseed and thus turning non-profit dormant days into profitable operating months.

This is not a doctor's clinic where we bring our achés and pains and ills to be prescribed for and cured. Rather, it is a clinic where we profit--profit not in terms of dollars and cents, but in terms of words of wisdom. We come here to learn from experts who know, and it is because of these experts and their words of wisdom that the cottonseed processing industry does look to the future.

ATTENDANCE LIST

Allen, Thomas E., Mississippi Valley Oilseed Processors Association, Inc., 1624 Exchange Bldg., Memphis, Tenn. 38103

Anderson, R. F., Delta Cotton Oil & Fertilizer Co., P. O. Box 899, Jackson, Miss. 39205

Baliga, B. P., M/S Tata Oils, Bombay 33, India

Bartmess, N. P., Kennett Oil Mill, Inc., P. O. Box 41, Kennett, Mo. 63857

Becker, Kenneth W., Blaw-Knox Chemical Plants, One Oliver Plaza, Pittsburgh, Pa. 15202

Bradham, D. A., Jr., P. O. Box 771, Greenvilee, Miss. 38701

Brady, Joe C., Helena Cotton Oil Co., Inc., P. O. Box 569, Helena, Ark. 72342

Campbell, Woodson E., Mississippi Cottonseed Products Co., P. O. Box 68, Hollandale, Miss. 38748

Carriere, C. M., The Southern Cotton Oil Co., 1701 National Bank of Commerce Bldg., 210 Baronne St., New Orleans, La. 70112

Cater, Carl M., Cottonseed Products Research Lab., F. E. Box 183, Texas A&M Univ., College Station, Tex. 77843

Circle, Sidney J., Anderson-Clayton Foods, W. L. Clayton Research Center, P. O. Box 63, Richardson, Tex. 75080

Clark, Elwood, USDA, ASCS Commodity Office, 120 Marais St., New Orleans, La. 70112

Cohen, Leon R., Imperial Citrus By-Products Corp., P. O. Box 1791, Lakeland, Fla. 33802

Covington, H. E., Mississippi Cottonseed Products Co., Box 939, Jackson, Miss. 39205

Covington, John E., Kosciusko Plant, Mississippi Cottonseed Products Co., P. O. Box 250, Kosciusko, Miss. 39090

Davis, Roy B., Plains Cooperative Oil Mill, P. O. Box 1889, Lubbock, Texas 79408

DeField, E. O., Sikeston Cotton Oil Mill, Inc., P. O. Box 430, Sikeston, Mo. 63801

Doak, Tom, Buying Division, Lever Bros Co., 390 Park Ave., New York, N. Y. 10022

Doughtie, R. T., Jr., Cottonseed Grading Cotton Div., Consumer and Marketing Service, USDA, 4841 Summer Ave., Memphis, Tenn. 38117

Dunklin, George H., Planters Cotton Oil Mill, P. O. Box 7427, Pine Bluff, Ark. 71601

Durham, Warren A., Nadustco, Inc., P. O. Box 52079, New Orleans, La. 70150

Dwoskin, Philip B., Marketing Economics Div., Economic Research Serv., USDA, Washington, D.C. 20250

Franks, Benny H., Planter of Pine Bluff, Pine Bluff, Ark. 71601

Gandy, Dalton E., National Cottonseed Products Association, Inc., P. O. Box 12023, Memphis, Tenn. 38112

Gaulding, E. A., Jr., Buckeye Cotton Oil Div., Buckeye Cellulose Corp., 4646 Poplar Ave., Memphis, Tenn. 38117

Gilbert, Hugh W., Osceola Products Co., P. O. Box 217, Osceola, Ark. 72370

Godchaux, Walter, Natustco, Inc., P. O. Box 52079, New Orleans, La. 70150

Grady, G. J., Sun Plant Products, Inc., Box 127, Gonvick, Minn. 56644

Hamilton, J. H., Barrow-Agee Laboratories, Inc., Box 156, Memphis, Tenn. 38101

Harper, Garlon A., National Cottonseed Products Association, P. O. Box 12023, Memphis, Tenn. 38112

Hayne, W. P., Independent Mill and Gin, Inc., P. O. Box 431, Alexandria, La. 71301

Hazelton, A. L., Producers Co-op Oil Mill, P. O. Box 26907, Oklahoma City, Okla. 73126

Hendrick, W. B., Anderson, Clayton & Co., Mexico, P. O. Box 1653, Guadalajara, Jalisco

Hicky, James, Forrest City Cotton Mill, Inc., Box 270, Forrest City, Ark. 72335

Hlavacek, Robert, J., Hunt-Wesson Foods, Inc., 1645 W. Valencia Dr., Fullerton, Calif. 92634

Hodges, Lawrence H., Barrow-Agee Labs. Inc., 1091 Cullenwood Dr., Memphis, Tenn. 38116

Holmes, Edward L., American Sanitation Inst., 884 Hodiamont Ave., St. Louis, Mo. 63112

Hughes, Jack, Yazoo Valley Oil Mill, Lock Drawer 1320, Greenwood, Miss. 38920

Jenkins, Alfred, Delta Cotton Oil & Fertilizer Co., P. O. Box 899, Jackson, Miss. 39205

Johanesen, Oscar C., Corn Products Co., Best Foods Div., 99 Avenue A., Bayonne, N. J. 07002

Johnson, W. J., Planters Oil Mill, P. O. Box 38, Tunica, Miss. 38676

Juge, Maurice C., Southern Testing Labs., 824 Marengo St., New Orleans, La. 70115

Katzenmier, C. Y., Jr., Port Gibson Oil Works, Box 336, Port Gibson, Miss. 39150

Keeton, Robert, The Procter & Gamble, Co., P. O. Box 599, Cincinnati, Ohio 45201

Kidd, Jack W., Farmers and Ginners Cotton Oil Co., 730 6th Ave. South, Birmingham, Ala. 35201

Kiesling, Irving, American Sanitation Inst., 884 Hodiamont Ave., St. Louis, Mo. 63112

Kingsbaker, C. L., Midwest District, Blaw-Knox Chemical Plants Div., 1 Oliver Plaza, Pittsburgh, Pa. 15222

Kinman Murray L., Dept. Soil & Crop Sciences, ARS, USDA, Texas A&M Univ., College Station, Tex. 77843

Langston, C. W., Hercules, Inc., 910 Market St., Wilmington, Del. 19899

Lanier, Willis P., Linter Purchases, Buckeye Cellulose Corp., 2899 Jackson Ave., Memphis, Tenn. 38108

Lawhon, J. T., Cottonseed Products Res. Lab., Texas A&M Univ., F. E. Box 183, College Sta., Tex. 77843

Letchworth, M. P., Leland Oil Works, Leland, Miss. 38756

Looney, J. E., Welding Engineers, Jefferson Rd., Marshall, TEx. 75670

Lyman, Carl M., Dept. Biochemistry & Biophysics, Texas A&M Univ., College Station, Tex. 77843

Mattil, Karl F., Texas A&M Univ., 216 Teague Research Center, College Station, Tex. 77843

Mays, J. R., Jr., Board of Directors, Barrow-Agee Labs., Inc., 1389 North Foster Dr., Baton Rouge, La. 70806

Miller, Dwight L., Northern Util. Res. & Develop. Div., 1815 N. University St., Peoria, Ill. 61604

Montague, Charlie, Buckeye Cellulose Corp., 2899 Jackson Ave., Memphis, Tenn. 38108

Moore, N. Hunt, N. Hunt Moore & Associates, 3951 Senator St., Memphis, Tenn. 38118

Morris, E. L., Hercules, Inc., 910 Market St., Wilmington, Del. 19899

Morrison, E. E., Eagle Cotton Oil Co., P. O. Box 608, Meridian, Miss. 39301

Page, Perryman, Delta OIl Mill, Inc., P. O. Box 138, Jonestown, Miss. 38639

Patton, E. L., Velsicol Chemical Corp., P. O. Box 7183, Jacksonville, Fla. 32210

Quinn, W. F., Minter City Oil Mill, Minter City, Miss. 38944

Reasor, George A., Hercules, Inc., 910 Market St., Wilmington, Del. 19899

Reiter, Harvey, Research & Development, Pepsi Co., 500 Park Ave., New York, N. Y. 10016

Roemer, Charles E., Walker-Roemer Dairies, P. O. Box 577, Metairie, La. 70004

Sablik, Kenneth, Standard Fruit & Steamship, International Trade Mart Bldg., No. 2 Canal St., New Orleans, La. 70130

Schwill, Ray O., Buckeye Cellulose Corp., 2899 Jackson Ave., Memphis, Tenn. 38108

Senti, Frederic R., Deputy Administrator, Nutrition, Consumer & Industrial Use Research, ARS, USDA, Room 309, Bldg. A., Washington, D. C. 20250

Shaw, Billy L., Southern Cotton Oil Co., P. O. Box 646, Macon, Ga. 31202

Shivers, J. C., Shelby Electric, 112 E. H. Crump Blvd. E., Memphis, Tenn. 38107

Sikes, James K., Plains Laboratory, P. O. Box 1590, Lubbock, Tex. 79408

Simpson, George R., Mississippi Cottonseed Prod., Co., P. O. Box 928, Greenwood, Miss. 38931

Sims, Bill, Ralston Purina, 835 South 8th St., Checkerboard Square, St. Louis, Mo. 63122
Smith, Allan K., 6026 Charlotte Dr., New Orleans, La. 70122

Smith, Keith J., National Cottonseed Products Association, P. O. Box 12023, Memphis, Tenn. 38112

Smith, Leonard, National Cotton Council, 1200 18th St., NW, Washington, D. C. 20036

Smith, Lloyd L., Transport & Facilities Research Div., ARS, USDA, Delta Branch Experiment Sta., Stoneville, Miss. 38776

Smith, Walton, The Southern Cotton Oil Co., Inc., 1701 National Bank of Commerce Bldg., New Orleans, La. 70112

Speel, Henry C., U. S. Dept. of Agr., 12th & Independence Ave., Washington, D. C. 20250

Summers, U. C., Shelby Electric, 112 E. H. Crump Blvd. E, Memphis, Tenn. 38107

Swaffar, T. J., Lamesa Cotton Oil Co., Division-Chickasha Cotton Oil Co., P. O. Box 421, Lamesa, Tex. 79331

Switzer, Sidney, French Oil Mill Machinery Co., 2825 College Plaza, Dallas, Tex. 75205

Tenent, E. H., Jr., Woodson-Tenent Labs, 265 S. Front St., Memphis, Tenn. 38102

Van Note, Robert H., International Administration, Dorr-Oliver, Inc., Stamford, Conn. 06904

Verdery, M. C., UNICEF, 1600 Holcombe Blvd., Houston, Tex. 77025

Wallace, G. F., The Union Oil Mill, Inc., P. O. Box 97, West Monroe, La. 71291

Watkins, Leslie B., Anderson, Clayton & Co., P. O. Box 2538, Houston, Tex. 77001

Weber, Lester J., Skelly OilCo., 605 West 47th St., Kansas City, Mo. 64141

Whitten, M. E., Cereal & Oilseeds Quality Inv., Market Quality Research Div., ARS, USDA, Agricultural Research Center, Beltsville, Md. 20705

Wilcke, Harold L., Ralston Purina Co., 835 S. 8th Street, Checkerboard Square, St. Louis, Mo. 63122

Wildrick, George, Lake County Oil Mill, P. O. Box 358, Tiptonville, Tenn. 38079

Williams, John E., USDA, C&MS, Cotton Div., 248 Leggett Dr., Abilene, Tex. 79605

Williams, Maurice A., V. D. Anderson Co., 1935 West 96th St., Cleveland, Ohio 44102

Williams, P. A., Hunt-Wesson Foods, P. O. Box 613, Waxahachie, Tex. 75165

Woodruff, Ralph C., Delta Products Co., Box 218, Wilson, Ark. 72395

Woodyard, H. M., Planters of Pine Bluff, 1021 East 5th, Pine Bluff, Ark. 71601

Woodyard, R. E., Carver Cotton Gin Co., 1305 Harbor Ave., Memphis, Tenn. 38106

Attendance of Personnel from the Southern Utilization Research and Development Division For at Least One Session of the Conference

Berardi, Leah C. (Mrs.) - Oilseed Crops Laboratory
Bergquist, Jack L. - Administrative and Plant Manager
Bourdette, Vernon R. - Public Information Director
Brugier, Emmy Lou (Mrs.) - Director's Office
Burke, Gloria L. (Mrs.) - Director's Office

Codifer, Louis P., Jr. - Oilseed Crops Laboratory
Conkerton, Edith J. (Mrs.) - Oilseed Crops Laboratory
Cross, Daniel E. - Engineering and Development Laboratory

Dechary, Joseph M. (Dr.) - Oilseed Crops Laboratory
Dollear, Frank G. - Oilseed Crops Laboratory

Eaves, Paul H. - Engineering and Development Laboratory

Fernandez, Charles J. - Oilseed Crops Laboratory
Feuge, Reuben O. - Oilseed Crops Laboratory
Fisher, C. H. (Dr.) - Director
Frampton, Vernon L. (Dr.) - Oilseed Crops Laboratory

Gajee, Betty B. (Mrs.) - Oilseed Crops Laboratory
Gardner, Homer K., Jr. - Engineering and Development Laboratory
Goldblatt, Leo A. (Dr.) - Oilseed Crops Laboratory

Hackney, Catherine O. (Mrs.) - Director's Office
Hennessey, Glen Rae (Mrs.) - Director's Office
Holzenthal, Leo L. - Engineering and Development Laboratory

Jacks, Thomas J. (Dr.) - Cotton Physical Properties Laboratory
Jones, Marie A. - Public Information Office
Jones, Mary Alice B. (Mrs.) - Director's Office

King, William H. - Cotton Physical Properties Laboratory
Knoepfler, Nestor B. - Engineering and Development Laboratory
Koenig, Paul A. - Engineering and Development Laboratory

Lambou, Madeline G. (Mrs.) - Engineering and Development Laboratory
Linstrom, Harold R. - Economic Research Service
Lovegren, Norman V. - Oilseed Crops Laboratory

Martinez, Wilda H. (Mrs.) - Oilseed Crops Laboratory
Mazzeno, Laurence W., Jr. - Assistant to the Director
Mottern, Hugh H. (Dr.) - Engineering and Development Laboratory

Neucere, Navin J. - Oilseed Crops Laboratory

O'Connor, Robert T. - Cotton Physical Properties Laboratory

Pearce, Ellen S. (Mrs.) - Director's Office
Pominski, Joseph - Engineering and Development Laboratory

Ramaswamy, H. N. (Dr.) - Cotton Physical Properties Laboratory
Riley, West, Jr. - Plant Management

St. Angelo, Allen J. (Dr.) - Oilseed Crops Laboratory
Saucier, Shirley T. (Mrs.) - Director's Office
Senn, Vincent J., (Dr.) - Oilseed Crops Laboratory
Simmons, Joseph G. - Oilseed Crops Laboratory
Soniat, Margaret B. (Mrs.) - Director's Office
Spadaro, James J. - Engineering and Development Laboratory
Stansbury, Mack F. - Assistant to the Director
Sumrell, Gene (Dr.) - Oilseed Crops Laboratory

Vix, Henry L. E. - Engineering and Development Laboratory

Weiss, Theodore J. (Dr.) - Oilseed Crops Laboratory
Williams, Nancy R. (Mrs.) - Economic Research Service
Wojcik, Bruno H. (Dr.) - Assistant Director

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
Southern Utilization Research & Development Division
P. O. BOX 19687
NEW ORLEANS, LOUISIANA 70119

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